2015-2016 National Monitoring Programs Annual Report (UATMP, NATTS, and CSATAM)

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LIST OF ACRONYMS

AADT	Annual Average Daily Traffic
AQS	Air Quality System
ASE	Accelerated Solvent Extractor
CBSA	Core-Based Statistical Area(s)
CFR	Code of Federal Regulations
CNG	Compressed Natural Gas
COC	Chain of Custody
CSATAM	Community-Scale Air Toxics Ambient Monitoring
CV	Coefficient of Variation
DNPH	2,4-Dinitrophenylhydrazine
DQI	Data Quality Indicator(s)
DQO	Data Quality Objective(s)
EPA	U.S. Environmental Protection Agency
ERG	Eastern Research Group, Inc.
FAC	Federal Advisory Committee
FEM	Federal Equivalent Method
GC/MS-FID	Gas Chromatography/Mass Spectrometry and Flame Ionization Detection
GC-FID	Gas Chromatography incorporating Flame Ionization Detection
HAP	Hazardous Air Pollutant(s)
HPLC	High-Performance Liquid Chromatography
HQ	Hazard Quotient
IC	Ion Chromatography
ICP-MS	Inductively Coupled Plasma/Mass Spectrometry
MDL	Method Detection Limit
mg/m^3	Milligrams per cubic meter
mL	Milliliter
MQO	Measurement Quality Objective(s)
NAAQS	National Ambient Air Quality Standard
NATA	National-Scale Air Toxics Assessment
NATTS	National Air Toxics Trends Stations
NCEI	National Centers for Environmental Information
ND	Non-detect
NEI	National Emissions Inventory
ng/m^3	Nanograms per cubic meter
NMOC	Non-Methane Organic Compound(s)
NMP	National Monitoring Programs
NOAA	National Oceanic and Atmospheric Administration
NWS	National Weather Service
PAH	Polycyclic Aromatic Hydrocarbon(s)
PM	Particulate Matter
PM_{10}	Particulate Matter less than 10 microns
POM	Polycyclic Organic Matter
ppbC	Parts per billion carbon

LIST OF ACRONYMS (Continued)

ppbv	Parts per billion by volume
ppmC	Parts per million carbon
PT	Proficiency Test
PUF	Polyurethane Foam
QAPP	Quality Assurance Project Plan
RfC	Reference Concentration(s)
SATMP	School Air Toxics Monitoring Program
SIM	Selected Ion Monitoring
SNMOC	Speciated Nonmethane Organic Compound(s)
TAD	Technical Assistance Document
TNMOC	Total Nonmethane Organic Compound(s)
tpy	Tons per year
TSP	Total Suspended Particulate
UATMP	Urban Air Toxics Monitoring Program
$\mu g/m^3$	Micrograms per cubic meter
µL	Microliter
URE	Unit Risk Estimate(s)
UV	Ultraviolet
VOC	Volatile Organic Compound(s)

Abstract

This report presents the results and conclusions from the ambient air monitoring conducted as part of the 2015 and 2016 National Monitoring Programs (NATTS, UATMP, and CSATAM) - three individual programs with different goals, but together result in a better understanding and appreciation of the nature and extent of toxic air pollution. The 2015-2016 NMP includes data from samples collected at 53 monitoring sites that collected 24-hour air samples, typically on a 1-in-6 or 1-in-12 day sampling schedule, and analyzed by the national contract laboratory. Twenty-seven sites sampled for 59 volatile organic compounds (VOCs); 31 sites sampled for 15 carbonyl compounds; nine sites sampled for 80 speciated nonmethane organic compounds (SNMOCs); 19 sites sampled for 22 polycyclic aromatic hydrocarbons (PAHs); 19 sites sampled for 11 metals; 2 sites samples for methane; and 1 site sampled for hexavalent chromium. More than 445,000 ambient air concentrations were measured during the 2015-2016 NMP under the national contract. This report uses various graphical, numerical, and statistical analyses to put the vast amount of ambient air monitoring data collected into perspective. Not surprisingly, the ambient air concentrations measured during the program varied from city-to-city, season-to-season, and year-to-year.

The ambient air monitoring data collected during the 2015 and 2016 NMP under the national contract serve a wide range of purposes. Not only do these data allow for the characterization of the nature and extent of air pollution close to the 53 individual monitoring sites participating in these programs, but they also exhibit trends and patterns that may be common to urban and rural environments and across the country. Therefore, this report presents results that are specific to particular monitoring locations and presents other results that are common to all environments. The results presented provide additional insight into the complex nature of air pollution. The raw data are included in the appendices of this report.

1.0 Introduction

Air pollution contains many components that originate from a wide range of stationary, mobile, and natural emissions sources. Because some of these components include air toxics that are known or suspected to have the potential for negative human health effects, the U.S. Environmental Protection Agency (EPA) encourages state, local, and tribal agencies to understand and appreciate the nature and extent of toxic air pollution in their respective locations or areas of administration. To achieve this goal, EPA sponsors the National Monitoring Programs (NMP), which includes the Urban Air Toxics Monitoring Program (UATMP), National Air Toxics Trends Stations (NATTS) network, Community-Scale Air Toxics Ambient Monitoring (CSATAM) Program, and monitoring for other pollutants such as speciated Non-Methane Organic Compounds (NMOCs). The UATMP, the NATTS, and the CSATAM programs include longer-term monitoring efforts (durations of one year or more) at specific locations. These programs have the following program-specific objectives (EPA, 2014):

- The primary technical objective of the UATMP is to characterize the composition and magnitude of air toxics pollution through ambient air monitoring. http://www.epa.gov/ttnamti1/uatm.html

- The primary technical objective of the NATTS network is to obtain a statistically significant quantity of high-quality representative air toxics measurements such that long-term trends can be identified. http://www.epa.gov/ttnamti1/natts.html

- The primary technical objective of the CSATAM Program is to conduct local-scale investigative ambient air toxics monitoring projects. http://www.epa.gov/ttnamti1/local.html

1.1 Background

The UATMP was initiated by EPA to meet the increasing need for information on air toxics. Over the years, the program has grown in both participation and targeted pollutants (EPA, 2014). The program has allowed for the identification of compounds that are prevalent in ambient air and for participating agencies to screen air samples for concentrations of air toxics that could potentially result in adverse human health effects.

The NATTS network was created to generate long-term ambient air toxics concentration data at specific fixed sites across the country. The 10-City Pilot Program (LADCO, 2003) was developed and implemented during 2001 and 2002, leading to the development and initial implementation of the NATTS network during 2003 and 2004. The goal of the program is to estimate the concentrations of air toxics on a national level from fixed sites that remain active over an extended period of time such that concentration trends (i.e., any substantial increase or

decrease over a period of time) may be identified (EPA, 2014). The data generated are also used for validating modeling results and emissions inventories, assessing current regulatory benchmarks, and assessing the potential for developing cancerous and noncancerous health effects (EPA, 2017a). The initial site locations were based on existing infrastructure of monitoring site locations (e.g., $PM_{2.5}$ network) and results from preliminary air toxics programs such as the 1996 National-scale Air Toxics Assessment (NATA), which used air toxics emissions data to model ambient monitoring concentrations across the nation. Monitoring sites were placed in both urban and rural locations. Urban areas were chosen to measure population exposure, while rural areas were chosen to determine background levels of air pollution and to assess impacts to non-urban areas (EPA, 2009a). Currently, 27 NATTS sites are strategically placed across the country (EPA, 2017a).

The CSATAM Program began in 2004 and is intended to support state, local, and tribal agencies in conducting ambient monitoring projects of approximately 2-year durations via periodic grant competitions. The objectives of the CSATAM Program include identifying and profiling sources of air toxics; developing and evaluating emerging measurement methods; characterizing the degree and extent of local air toxics problems; and tracking progress attributable to air toxics reduction activities (EPA, 2014).

1.2 The Report

Many environmental and health agencies have participated in these programs to assess the sources, effects, and changes in air pollution within their jurisdictions. This report summarizes and interprets measurements collected at monitoring sites participating in the UATMP, NATTS, and CSATAM programs in 2015 and 2016. Included in this report are data from sites whose operating agencies have opted to have their samples analyzed by EPA's national contract laboratory, Eastern Research Group, Inc. (ERG). Agencies operating sites under the NMP are not required to have their samples analyzed by ERG or may not have samples for all methods analyzed by ERG, as they may have their own laboratories or use other laboratories. In these cases, data are generated by sources other than ERG and are not included in this report. In addition, a state, local, or tribal agency may opt to use the national contract for a specialized, more targeted air toxics monitoring study in which their data are included in the report as well. The purpose of this report is to summarize and characterize those data generated by the contract laboratory over the 2015 and 2016 monitoring efforts.

In past reports, measurements from UATMP, NATTS, and CSATAM monitoring sites have been presented together and referred to as "UATMP sites." In more recent reports, including the 2015-2016 report, a distinction has been made among the three programs due to the increasing number of sites covered under each program. Thus, it is appropriate to describe each program; to distinguish among their purposes and scopes; and to integrate the data, which allows each program's objectives and goals to complement one another.

Included in this report are data collected at 53 monitoring sites around the country. The 53 sites whose data are included in this report are located in or near 30 urban or rural locations in 18 states and the District of Columbia, including 28 metropolitan or micropolitan statistical areas (collectively referred to as core-based statistical areas or CBSAs).

The purpose of this report is to summarize and characterize those data generated by the contract laboratory during the 2015 and 2016 monitoring efforts.

This report provides both a qualitative overview of air toxics pollution at participating urban and rural locations and a quantitative data analysis of the factors that appear to most significantly affect the behavior of air toxics in urban and rural areas. This report also focuses on data summaries and characterizations for each of the 53 different air monitoring locations, a site-specific approach that allows for a much more detailed evaluation of the factors (e.g., emissions sources, natural sources, meteorological influences) that affect air quality differently from one location to the next. Much of the data analysis and interpretation contained in this report focuses on pollutant-specific risk potential.

This report offers participating agencies relevant information and insight into important air quality issues. For example, participating agencies can use trends and patterns in the monitoring data to determine whether levels of air pollution as reported present public health concerns, to identify which emissions sources contribute most to air pollution, and/or to forecast whether proposed pollution control initiatives could (or have) significantly improved air quality. Monitoring data may also be compared to modeling results, such as from EPA's NATA. Policy-relevant questions that the monitoring data may help answer include the following:

- Which anthropogenic sources substantially affect air quality?
- Have pollutant concentrations decreased as a result of regulations (or increased despite regulation)?
- Which pollutants contribute the greatest health risk on a short-term, intermediate-term, and long-term basis?

The data analyses contained in this report are applied to each participating UATMP, NATTS, or CSATAM monitoring site, depending upon pollutants sampled and duration of monitoring. Although many types of data analyses are presented, state and local environmental agencies are encouraged to perform additional evaluations of the monitoring data so that the many factors that affect their specific ambient air quality can be understood fully.

To facilitate examination of the 2015-2016 UATMP, NATTS, and CSATAM monitoring data, henceforth referred to as NMP data, the complete set of measurements is presented in the appendices of this report. In addition, these data are publicly available in electronic format from EPA's Air Quality System (AQS) (EPA, 2017b).

The 2015-2016 report is organized into 26 sections and 17 appendices. While each state section is designed to be a stand-alone section to allow those interested in a particular site or state to understand the associated data analyses without having to read the entire report, it is recommended that Sections 1 through 4 (Introduction, Monitoring Programs Network, Data Treatments and Methods, and Summary of NMP Data) and Sections 24 and 25 (Data Quality and Results, Conclusions, and Recommendations) be read as complements to the individual state sections. Table 1-1 highlights the contents of each section.

Table 1-1. Organization of the 2015-2016 National Monitoring Programs Report

Report Section	Section Title	Overview of Contents
1	Introduction	This section serves as an introduction to the background, objectives, and scope of specific element of EPA's NMP (specifically, the UATMP, NATTS, and CSATAM Programs).
2	The 2015-2016 National Monitoring Programs Network	This section provides an overview on the 2015-2016 NMP monitoring effort, including: • Monitoring locations • Pollutants selected for monitoring • Sampling and analytical methods • Sampling schedules • Completeness of the air monitoring programs.
3	Summary of the 2015-2016 National Monitoring Programs Data Treatments and Methods	This section presents and discusses the data treatments applied to the 2015-2016 NMP data to determine significant trends and relationships in the data, characterize data based on how ambient air concentrations varied with monitoring location and with time, interpret the significance of the observed spatial and temporal variations, and evaluate human health risk.
4	Summary of the 2015-2016 National Monitoring Programs Data	This section presents and discusses the results of the data analyses from the 2015-2016 NMP data.
5	Sites in Arizona	Monitoring results for the sites in the Phoenix-Mesa-Scottsdale, AZ CBSA (PXSS and SPAZ)
6	Sites in California	Monitoring results for the sites in the Los Angeles-Long Beach-Anaheim, CA CBSA (CELA), the Riverside-San Bernardino-Ontario, CA CBSA (RUCA), and the San Jose-Sunnyvale-Santa Clara, CA CBSA (SJJCA)

Table 1-1. Organization of the 2015-2016 National Monitoring Programs Report (Continued)

Report Section	Section Title	Overview of Contents
7	Sites in Colorado	Monitoring results for the sites in the Grand Junction, CO CBSA (GPCO) and the Glenwood Springs, CO CBSA (BMCO, BRCO, GSCO, PACO, RFCO, and RICO)
8	Site in the District of Columbia	Monitoring results for the site in the Washington-Arlington-Alexandria, DC-VA-MD-WV CBSA (WADC)
9	Sites in Florida	Monitoring results for the sites in the Orlando-Kissimmee-Sanford, FL CBSA (ORFL and PAFL) and the Tampa-St. Petersburg-Clearwater, FL CBSA (AZFL, SKFL, and SYFL)
10	Sites in Illinois	Monitoring results for the sites in the Chicago-Naperville-Elgin, IL-IN-WI CBSA (NBIL and SPIL) and the St. Louis, MO-IL CBSA (ROIL)
11	Sites in Indiana	Monitoring results for the sites in the Chicago- Naperville-Elgin, IL-IN-WI CBSA (INDEM) and the Indianapolis-Carmel-Anderson, IN CBSA (WPIN)
12	Sites in Kentucky	Monitoring results for the sites in the Huntington-Ashland, WV-KY-OH CBSA (ASKY and ASKY-M), the Lexington-Fayette, KY CBSA (LEKY), the Evansville, IN-KY CBSA (BAKY), the Paducah, KY-IL CBSA (BLKY), and the sites in Marshall County (ATKY and TVKY) and Carter County (GLKY)
13	Site in Massachusetts	Monitoring results for the site in the Boston-Cambridge-Newton, MA-NH CBSA (BOMA)
14	Site in Michigan	Monitoring results for the site in the Detroit-Warren-Dearborn, MI CBSA (DEMI)
15	Site in Missouri	Monitoring results for the site in the St. Louis, MO-IL CBSA (S4MO)
16	Sites in New Jersey	Monitoring results for the sites in the New York-Newark-Jersey City, NY-NJ-PA CBSA (CHNJ, ELNJ, NBNJ, and NRNJ) and the Philadelphia-Camden-Wilmington, PA-NJ-DE-MD CBSA (CSNJ)
17	Sites in New York	Monitoring results for the sites in the New York-Newark-Jersey City, NY-NJ-PA CBSA (BXNY) and the Rochester, NY CBSA (ROCH)
18	Sites in Oklahoma	Monitoring results for the sites in the Tulsa, OK CBSA (TOOK, TMOK, and TROK), and the Oklahoma City, OK CBSA (BROK, NROK, OCOK, and YUOK)
19	Site in Rhode Island	Monitoring results for the site in the Providence-Warwick, RI-MA CBSA (PRRI)
20	Site in Utah	Monitoring results for the site in the Ogden-Clearfield, UT CBSA (BTUT)
21	Site in Vermont	Monitoring results for the site in the Burlington-South Burlington, VT CBSA (UNVT)
22	Site in Virginia	Monitoring results for the site in the Richmond, VA CBSA (RIVA)
23	Site in Washington	Monitoring results for the site in the Seattle-Tacoma-Bellevue, WA CBSA (SEWA)
24	Data Quality	This section defines and discusses the general concepts of precision and accuracy. Based on quantitative and qualitative analyses, this section comments on the specific precision and accuracy of the 2015-2016 NMP ambient air monitoring data.
25	Results, Conclusions, and Recommendations	This section summarizes the most significant findings of the report and makes several recommendations for future projects that involve ambient air monitoring.
26	References	This section lists the references cited throughout the report.

2.0 The 2015-2016 National Monitoring Programs Network

Agencies operating UATMP, NATTS, or CSATAM sites may choose to have their samples analyzed by EPA's contract laboratory, ERG, in Morrisville, North Carolina. This report report summarizes and characterizes data generated for agencies that chose to have ERG provide analytical services and monitoring support. Data included in this report are from 53 monitoring sites that collected 24-hour integrated ambient air samples for up to 24 months, at 1-in-6 or 1-in-12 day sampling intervals, and sent them to ERG for analysis. Samples were analyzed for concentrations of the following suites of pollutants:

- selected hydrocarbons, halogenated hydrocarbons, and polar compounds from canister samples for Speciated Non-Methane Organic Compounds (SNMOCs) and/or Volatile Organic Compounds (VOCs) using EPA Compendium Method TO-15,
- carbonyl compounds from sorbent cartridge samples using EPA Compendium Method TO-11A,
- polycyclic aromatic hydrocarbons (PAHs) from polyurethane foam (PUF) and XAD-2® resin samples using EPA Compendium Method TO-13A,
- trace metals from filters using EPA Compendium Method IO-3.5/Federal Equivalency Methods (FEM) EQL-0512-201 or EQL-0512-202, and
- hexavalent chromium from sodium bicarbonate-coated filters using ASTM D7614.

Agencies operating sites under the NMP are not required to have their samples analyzed by ERG. They may have samples for only select methods analyzed by ERG, as they may have their own laboratory capabilities for other methods. In these cases, data are generated by sources other than ERG and are therefore not included in this report.

Two sites participating in the NMP during 2015 and 2016 also submitted their canister samples for methane analysis as part of a special study. While not an official part of the NMP, additional information regarding this sampling methodology, along with the other methods listed above, is provided in Section 2.2.

The following sections review the monitoring locations, pollutants selected for monitoring, sampling and analytical methods, collection schedules, and completeness of the 2015-2016 NMP dataset.

2.1 Monitoring Locations

For the NATTS network, monitor siting is based on the need to assess population exposure and/or background-level concentrations. For the UATMP and CSATAM programs, representatives from the state, local, and tribal agencies that voluntarily participate in the

programs select the monitoring locations based on specific siting criteria and study needs. Among these programs, monitors were placed in urban areas near the centers of heavily populated cities (e.g., Chicago, Illinois and Phoenix, Arizona), while others were placed in moderately or sparsely populated rural areas (e.g., Grayson, Kentucky and Underhill, Vermont).

Figure 2-1 shows the locations of the 53 monitoring sites participating in the 2015 and 2016 monitoring programs under the national contract, which encompass 30 different urban and rural areas. Outlined in Figure 2-1 are the associated CBSAs, as designated by the U.S. Census Bureau, where each site is located (Census Bureau, 2015). A CBSA refers to either a metropolitan (an urban area with 50,000 or more people) or micropolitan (an urban area with at least 10,000 people but less than 50,000 people) statistical area (Census Bureau, 2017). Table 2-1 lists the respective monitoring program and the years of program participation under the national contract for the 53 monitoring sites. Most of the monitoring sites have been included in at least one previous NMP annual report; only BROK, GSCO, NRNJ, and NROK did not participate in the NMP prior to 2015.

As Figure 2-1 and Table 2-1 show, the 2015-2016 NMP sites are widely distributed across the country. Detailed information about the monitoring sites is provided in Table 2-2, Appendix A, and the individual state sections (Sections 5 through 23). Monitoring sites that are designated as part of the NATTS network are indicated by bold italic type in Table 2-1 and subsequent tables throughout this report. Table 2-2 shows that the locations of the monitoring sites vary significantly, depending on the individual program's technical objectives. These sites are located in areas of differing elevation, population, land use, climatology, and topography. A more detailed look at each monitoring site's surroundings is provided in the individual state sections.

For record-keeping and reporting purposes, each site was assigned the following:

- A unique four or five-letter site code used to track samples from the monitoring site to the ERG laboratory.
- A unique nine-digit AQS site code used to index monitoring results in the AQS database.

This report cites the four or five-letter site code when presenting monitoring results. For reference, each site's AQS site code is provided in Table 2-2.

Figure 2-1. Locations of the 2015-2016 National Monitoring Programs Monitoring Sites[1]

[1] Includes monitoring sites participating under the NMP with the national contract laboratory.

Table 2-1. 2015-2016 National Monitoring Programs Sites and Past Program Participation[1]

Monitoring Location (and Site Name)	Program	2006 and Earlier	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Ashland, KY (ASKY)	UATMP							✓	✓	✓	✓	✓
Ashland, KY (ASKY-M)	UATMP							✓	✓	✓	✓	✓
Baskett, KY (BAKY)	UATMP							✓	✓	✓	✓	✓
Battlement Mesa, CO (BMCO)	UATMP					✓	✓	✓	✓	✓	✓	✓
Boston, MA ***(BOMA)***	NATTS	2003–2006	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Bountiful, UT ***(BTUT)***	NATTS	2003–2006	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Bradley, OK (BROK)	UATMP										✓	✓
Calvert City, KY (ATKY)	UATMP							✓	✓	✓	✓	✓
Calvert City, KY (TVKY)	UATMP							✓	✓	✓	✓	✓
Camden, NJ (CSNJ)	UATMP								✓	✓	✓	✓
Carbondale, CO (RFCO)	UATMP							✓	✓	✓	✓	✓
Chester, NJ (CHNJ)	UATMP	2001- 2006	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Dearborn, MI ***(DEMI)***	NATTS	2001- 2006	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
East Brunswick, NJ (NRNJ)	UATMP											✓
East Highland Park, VA (***RIVA***)	NATTS			✓	✓	✓	✓	✓	✓	✓	✓	✓
Elizabeth, NJ (ELNJ)	UATMP	1999-2006	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Gary, IN (INDEM)	UATMP	2004-2006	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

BOLD ITALICS = EPA-designated NATTS site

[1] Includes monitoring sites participating under the NMP with the national contract laboratory

Table 2-1. 2015-2016 National Monitoring Programs Sites and Past Program Participation[1] (Continued)

Monitoring Location (and Site Name)	Program	2006 and Earlier	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Glenwood Springs, CO (GSCO)	UATMP										✓	✓
Grand Junction, CO ***(GPCO)***	NATTS	2004-2006	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Grayson, KY ***(GLKY)***	NATTS			✓	✓	✓	✓	✓	✓	✓	✓	✓
Indianapolis, IN (WPIN)	UATMP	2006	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Lexington, KY (LEKY)	UATMP							✓	✓	✓	✓	✓
Los Angeles, CA (***CELA***)	NATTS		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Bronx, NY (***BXNY***)	NATTS	2006	✓	✓	✓	✓		✓	✓	✓	✓	✓
North Brunswick, NJ (NBNJ)	UATMP	2001- 2006	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Northbrook, IL (***NBIL***)	NATTS	2003-2006	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Oklahoma City, OK (OCOK)	UATMP				✓	✓	✓	✓	✓	✓	✓	✓
Oklahoma City, OK (NROK)	UATMP											✓
Orlando, FL (PAFL)	UATMP			✓	✓	✓	✓	✓	✓	✓	✓	✓
Parachute, CO (PACO)	UATMP			✓	✓	✓	✓	✓	✓	✓	✓	✓
Phoenix, AZ (***PXSS***)	NATTS	2001- 2004, 2006	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Phoenix, AZ (SPAZ)	UATMP	2001	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Pinellas Park, FL (***SKFL***)	NATTS	2004-2006	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Providence, RI (***PRRI***)	NATTS	2005-2006	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

BOLD ITALICS = EPA-designated NATTS site

[1] Includes monitoring sites participating under the NMP with the national contract laboratory

Table 2-1. 2015-2016 National Monitoring Programs Sites and Past Program Participation[1] (Continued)

Monitoring Location (and Site Name)	Program	2006 and Earlier	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Rifle, CO (RICO)	UATMP			✓	✓	✓	✓	✓	✓	✓	✓	✓
Rochester, NY (***ROCH***)	NATTS	2006	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Roxana, IL (ROIL)	UATMP							✓	✓	✓	✓	
Rubidoux, CA (***RUCA***)	NATTS		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
San Jose, CA (***SJJCA***)	NATTS			✓	✓	✓	✓	✓	✓	✓	✓	✓
Schiller Park, IL (SPIL)	UATMP	2003-2006	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Seattle, WA (***SEWA***)	NATTS	2005-2006	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Silt, CO (BRCO)	UATMP			✓	✓	✓	✓	✓	✓	✓	✓	✓
Smithland, KY (BLKY)	UATMP							✓	✓	✓	✓	✓
St. Louis, MO (***S4MO***)	NATTS	2002, 2003-2006	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
St. Petersburg, FL (AZFL)	UATMP	1991-1992, 2001-2006	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Tulsa, OK (TMOK)	UATMP				✓	✓	✓	✓	✓	✓	✓	✓
Tulsa, OK (TOOK)	UATMP	2006	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Tulsa, OK (TROK)	UATMP								✓	✓	✓	✓
Underhill, VT (***UNVT***)	NATTS	2002, 2005-2006	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Valrico, FL (***SYFL***)	NATTS	2004-2006	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Washington, D.C. (***WADC***)	NATTS	2005-2006	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

BOLD ITALICS = EPA-designated NATTS site

[1] Includes monitoring sites participating under the NMP with the national contract laboratory

Table 2-1. 2015-2016 National Monitoring Programs Sites and Past Program Participation[1] (Continued)

Monitoring Location (and Site Name)	Program	2006 and Earlier	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Winter Park, FL (ORFL)	UATMP	1990-1991, 2003-2006	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Yukon, OK (YUOK)	UATMP								✓	✓	✓	✓

BOLD ITALICS = EPA-designated NATTS site

[1] Includes monitoring sites participating under the NMP with the national contract laboratory

Table 2-2. Site Characterizing Information for the 2015-2016 National Monitoring Programs Sites

Site Code	AQS Code	Location	Land Use	Location Setting	Estimated Daily Traffic, AADT[a] (Year)	County-level Stationary Source HAP Emissions[b] (tpy)	County-level Mobile Source HAP Emissions[b] (tpy)
ASKY	21-019-0017	Ashland, KY	Residential	Suburban	5,934 (2014)	170.82	140.50
ASKY-M	21-019-0002	Ashland, KY	Industrial	Urban/City Center	13,241 (2015)	170.82	140.50
ATKY	21-157-0016	Calvert City, KY	Industrial	Suburban	3,672 (2015)	1,100.01	494.44
AZFL	12-103-0018	St. Petersburg, FL	Residential	Suburban	39,000 (2016)	1,513.94	2,866.11
BAKY	21-101-0014	Baskett, KY	Commercial	Rural	929 (2015)	541.67	232.81
BLKY	21-139-0004	Smithland, KY	Agricultural	Rural	2,011 (2016)	21.88	124.88
BMCO	08-045-0019	Battlement Mesa, CO	Commercial	Suburban	1,880 (2014)	4,509.05	246.90
BOMA	25-025-0042	Boston, MA	Commercial	Urban/City Center	27,654 (2010)	771.94	978.39
BRCO	08-045-0009	Silt, CO	Agricultural	Rural	1,182 (2014)	4,509.05	246.90
BROK	40-051-0065	Bradley, OK	Residential	Rural	3,100 (2015)	736.53	208.62
BTUT	49-011-0004	Bountiful, UT	Residential	Suburban	133,965 (2014)	461.96	792.60
BXNY	36-005-0110	Bronx, NY	Residential	Urban/City Center	100,898 (2015)	1,203.95	974.59
CELA	06-037-1103	Los Angeles, CA	Residential	Urban/City Center	231,000 (2015)	12,908.63	11,950.01
CHNJ	34-027-3001	Chester, NJ	Agricultural	Rural	11,215 (2012)	717.64	1,270.98
CSNJ	34-007-0002	Camden, NJ	Industrial	Urban/City Center	3,231 (2012)	672.99	849.53

BOLD ITALICS = EPA-designated NATTS site

[a] Individual references provided in each state section.

[b] Reference: 2014 NEI, version 1 (EPA, 2016)

[c] GPCO's metals collection system is at a separate, but adjacent, location; thus, this site has two AQS codes.

[d] S4MO's emissions are city-level + county-level data.

Table 2-2. Site Characterizing Information for the 2015-2016 National Monitoring Programs Sites (Continued)

Site Code	AQS Code	Location	Land Use	Location Setting	Estimated Daily Traffic, AADT[a] (Year)	County-level Stationary Source HAP Emissions[b] (tpy)	County-level Mobile Source HAP Emissions[b] (tpy)
DEMI	26-163-0033	Dearborn, MI	Industrial	Suburban	86,600 (2015)	5,424.72	4,590.35
ELNJ	34-039-0004	Elizabeth, NJ	Industrial	Suburban	250,000 (2006)	801.13	969.16
GLKY	21-043-0500	Grayson, KY	Residential	Rural	303 (2012)	43.80	103.35
GPCO[c]	08-077-0017 08-077-0018	Grand Junction, CO	Commercial	Urban/City Center	12,000 (2015)	525.20	509.82
GSCO	08-045-0020	Glenwood Springs, CO	Commercial	Suburban	27,000 (2015)	4,509.05	246.90
INDEM	18-089-0022	Gary, IN	Industrial	Urban/City Center	41,860 (2016)	1,128.12	1,605.34
LEKY	21-067-0012	Lexington, KY	Residential	Suburban	18,993 (2014)	398.52	1,124.81
NBIL	17-031-4201	Northbrook, IL	Residential	Suburban	115,100 (2014)	13,088.01	10,072.89
NBNJ	34-023-0006	North Brunswick, NJ	Agricultural	Rural	114,322 (2010)	1,139.75	1,562.28
NRNJ	34-023-0011	East Brunswick, NJ	Agricultural	Rural	22,297 (2014)	1,139.75	1,562.28
NROK	40-109-0097	Oklahoma City, OK	Commercial	Urban/City Center	167,600 (2015)	1,508.04	2,790.29
OCOK	40-109-1037	Oklahoma City, OK	Residential	Suburban	52,500 (2015)	1,508.04	2,790.29
ORFL	12-095-2002	Winter Park, FL	Commercial	Urban/City Center	33,000 (2016)	2,204.15	3,938.70
PACO	08-045-0005	Parachute, CO	Residential	Urban/City Center	17,000 (2015)	4,509.05	246.90
PAFL	12-095-1004	Orlando, FL	Commercial	Suburban	50,000 (2016)	2,204.15	3,938.70

BOLD ITALICS = EPA-designated NATTS site

[a] Individual references provided in each state section.

[b] Reference: 2014 NEI, version 1 (EPA, 2016)

[c] GPCO's metals collection system is at a separate, but adjacent, location; thus, this site has two AQS codes.

[d] S4MO's emissions are city-level + county-level data.

Table 2-2. Site Characterizing Information for the 2015-2016 National Monitoring Programs Sites (Continued)

Site Code	AQS Code	Location	Land Use	Location Setting	Estimated Daily Traffic, AADT[a] (Year)	County-level Stationary Source HAP Emissions[b] (tpy)	County-level Mobile Source HAP Emissions[b] (tpy)
PRRI	44-007-0022	Providence, RI	Residential	Urban/City Center	148,000 (2015)	874.24	1,353.77
PXSS	04-013-9997	Phoenix, AZ	Residential	Urban/City Center	35,103 (2010)	4,268.89	9,747.67
RFCO	08-045-0018	Carbondale, CO	Residential	Rural	18,000 (2015)	4,509.05	246.90
RICO	08-045-0007	Rifle, CO	Commercial	Urban/City Center	16,000 (2015)	4,509.05	246.90
RIVA	51-087-0014	East Highland Park, VA	Residential	Suburban	80,000 (2016)	721.62	838.70
ROCH	36-055-1007	Rochester, NY	Residential	Urban/City Center	85,833 (2015)	3,485.92	1,703.05
ROIL	17-119-9010	Roxana, IL	Industrial	Suburban	6,850 (2015)	1,119.13	896.15
RUCA	06-065-8001	Rubidoux, CA	Residential	Suburban	166,000 (2015)	2,253.98	2,699.06
S4MO[d]	29-510-0085	St. Louis, MO	Residential	Urban/City Center	57,558 (2015)	2,109.40	3,912.01
SEWA	53-033-0080	Seattle, WA	Residential	Urban/City Center	186,000 (2015)	3,294.34	6,232.04
SJJCA	06-085-0005	San Jose, CA	Commercial	Urban/City Center	126,000 (2015)	1,561.19	1,852.36
SKFL	12-103-0026	Pinellas Park, FL	Residential	Suburban	4,000 (2016)	1,513.94	2,866.11
SPAZ	04-013-4003	Phoenix, AZ	Residential	Urban/City Center	21,601 (2015)	4,268.89	9,747.67
SPIL	17-031-3103	Schiller Park, IL	Mobile	Suburban	193,800 (2013)	13,088.01	10,072.89
SYFL	12-057-3002	Valrico, FL	Residential	Rural	3,900 (2016)	5,295.52	3,909.38

BOLD ITALICS = EPA-designated NATTS site

[a] Individual references provided in each state section.

[b] Reference: 2014 NEI, version 1 (EPA, 2016)

[c] GPCO's metals collection system is at a separate, but adjacent, location; thus, this site has two AQS codes.

[d] S4MO's emissions are city-level + county-level data.

Table 2-2. Site Characterizing Information for the 2015-2016 National Monitoring Programs Sites (Continued)

Site Code	AQS Code	Location	Land Use	Location Setting	Estimated Daily Traffic, AADT[a] (Year)	County-level Stationary Source HAP Emissions[b] (tpy)	County-level Mobile Source HAP Emissions[b] (tpy)
TMOK	40-143-1127	Tulsa, OK	Residential	Urban/City Center	4,400 (2015)	1,297.42	2,416.72
TOOK	40-143-0235	Tulsa, OK	Industrial	Urban/City Center	66,800 (2015)	1,297.42	2,416.72
TROK	40-143-0179	Tulsa, OK	Industrial	Urban/City Center	55,400 (2015)	1,297.42	2,416.72
TVKY	21-157-0014	Calvert City, KY	Industrial	Suburban	1,458 (2014)	1,100.01	494.44
UNVT	50-007-0007	Underhill, VT	Forest	Rural	970 (2014)	420.26	439.52
WADC	11-001-0043	Washington, D.C.	Commercial	Urban/City Center	3,600 (2014)	557.33	874.26
WPIN	18-097-0078	Indianapolis, IN	Residential	Suburban	24,917 (2016)	2,042.54	3,429.15
YUOK	40-017-0101	Yukon, OK	Commercial	Suburban	42,900 (2015)	901.24	358.36

BOLD ITALICS = EPA-designated NATTS site

[a] Individual references provided in each state section.

[b] Reference: 2014 NEI, version 1 (EPA, 2016)

[c] GPCO's metals collection system is at a separate, but adjacent, location; thus, this site has two AQS codes.

[d] S4MO's emissions are city-level + county-level data.

The proximity of the monitoring sites to different emissions sources, especially industrial facilities and heavily traveled roadways, often explains the observed spatial variations in ambient air quality. To provide a first approximation of the potential contributions of stationary and mobile source emissions on ambient air quality at each site, Table 2-2 also lists the following:

- The number of vehicles passing the nearest available representative roadway to the monitoring site, generally expressed as annual average daily traffic (AADT).
- Stationary and mobile source hazardous air pollutant (HAP) emissions for the monitoring site's residing county, according to version 1 of the 2014 National Emissions Inventory (NEI). (Version 2 of the 2014 NEI was published in the middle of the production of the 2015-2016 NMP report and will be utilized in the 2017 NMP report.)

This information is discussed in further detail in the individual state sections (Sections 5 through 23).

2.2 Analytical Methods and Pollutants Targeted for Monitoring

Air pollution typically contains hundreds of components, including, but not limited to, VOCs, metals, and particulate matter (PM). Because the sampling and analysis required to monitor for every component of air pollution has been prohibitively expensive, the NMP focuses on specific pollutants that are analyzed at the laboratory using methods based on the EPA-approved methods, as listed below:

- *Compendium Method TO-15* was used to measure ambient air concentrations of 59 VOCs.
- *EPA-approved SNMOC Method* was used to measure 80 ozone precursors plus total NMOC. This method can be performed concurrently with Method TO-15.
- *Compendium Method TO-11A* was used to measure ambient air concentrations of 15 carbonyl compounds.
- A combination of *Compendium Method TO-13A* and *ASTM D6209* was used to measure ambient air concentrations of 22 PAHs.
- A combination of *Compendium Method IO-3.5* and *EPA FEM EQL-0512-201* or *EQL-0512-202* was used to measure ambient air concentrations of 11 metals.
- *ASTM Method D7614* was used to measure ambient air concentrations of hexavalent chromium.
- *EPA-approved Methane Method* was used to measure ambient air concentrations of methane.

The target pollutants and methods utilized varied from monitoring site to monitoring site. The sample collection equipment at each site was installed either as a stand-alone collection system or in a temperature-controlled enclosure (usually a trailer or a shed) with the sampling probe inlet exposed to the ambient air. With these common setups, most monitoring sites sampled ambient air at heights approximately 5 feet to 20 feet above local ground level.

The detection limits of the analytical methods must be considered carefully when interpreting the corresponding ambient air monitoring data. By definition, method detection limits (MDLs) represent the lowest concentrations at which laboratory equipment have been experimentally determined to quantify concentrations of selected pollutants to a specific confidence level. If a pollutant's concentration in ambient air is less than the method sensitivity (as gauged by the MDL), the analytical method might not differentiate the pollutant from other pollutants in the sample or from the random "noise" inherent in the analyses. While quantification less than the MDL is possible, the measurement reliability is lower. Therefore, when pollutants are present at concentrations less than their respective detection limits, multiple analyses of the same sample may lead to a wide range of measurement results, including highly variable concentrations or "non-detect" observations (i.e., the pollutant was not detected by the instrument). Data analysts should exercise caution when interpreting monitoring data with a high percentage of reported concentrations at levels near or less than the corresponding detection limits.

MDLs are determined annually at the ERG laboratory using procedures outlined in the U.S. Code of Federal Regulations (CFR), specifically 40 CFR, Part 136 Appendix B (EPA, 1986), in accordance with the specifications presented in the NATTS Technical Assistance Document (TAD) (EPA, 2009a). This procedure involves analyzing at least seven replicate standards spiked onto the appropriate sampling media and extracted (per analytical method). Instrument-specific detection limits (replicate analysis of standards in solution) are not determined because sampling media background and preparation variability would not be considered. (Note that the 2016 NATTS TAD revisions went into effect at the end of 2017, and thus, the updates to MDL determination are not applicable to the 2015-2016 NMP dataset).

MDLs for metals samples were calculated using the procedure described by "Appendix D: DQ FAC Single Laboratory Procedure v2.4" (FAC, 2007), with the exception of the arsenic MDL for Teflon® filters. The Federal Advisory Committee (FAC) MDL procedure involves using historical blank filter data to calculate MDLs for each pollutant. For arsenic, the

procedure described in 40 CFR was used to calculate the MDL rather than the FAC procedure because this metal is not present at a high enough level in the background on the filters. In the fall of 2015, the ERG laboratory obtained and employed a new Inductively Coupled Plasma/Mass Spectrometry (ICP-MS) instrument. During this time, the FAC procedure for determining MDLs was implemented for all 11 target analytes, such that all MDLs were determined using the FAC approach.

Tables 2-3 through 2-9 identify the specific target pollutants for each analytical method and their experimentally determined MDLs, as determined at the ERG laboratory for 2015 and 2016. For individual samples, the MDLs for VOC and SNMOC analyses do not change unless the sample was diluted.

The following discussion presents an overview of the sampling and analytical methods. For detailed descriptions of the methods, refer to EPA's original documentation of the Compendium Methods (EPA, 1998; EPA, 1999a; EPA, 1999b; EPA, 1999c; EPA, 1999d; EPA, 2012; ASTM, 2012; ASTM, 2013; and SAE, 2011).

2.2.1 Sampling and Analytical Methods for Canister Samples (VOC, SNMOC, and Methane)

VOC and SNMOC sampling and analysis are performed using methodology based on EPA Compendium Method TO-15 (EPA, 1999a) and the procedure presented in EPA's "Technical Assistance Document for Sampling and Analysis of Ozone Precursors" (EPA, 1998), respectively. Because the TO-15 and SNMOC methods can be employed at the same time to analyze the same canister sample, this report may refer to the SNMOC method as the "concurrent" SNMOC method. Ambient air samples for VOC and/or SNMOC analysis were collected in passivated stainless steel canisters. The ERG laboratory distributed the prepared canisters (i.e., cleaned and evacuated) to the monitoring sites before each scheduled sample collection event, and site operators connected the canisters to air sampling equipment prior to each sample day. Prior to field sampling, the passivated canisters had internal pressures much lower than atmospheric pressure. Using this pressure differential, ambient air flowed into the canisters automatically once an associated system solenoid valve was opened. A mass flow controller on the sampling device inlet ensured that ambient air entered the canister at an integrated constant rate across the collection period. At the end of the 24-hour sampling period, the solenoid valve automatically closed and stopped ambient air from flowing into the canister.

Site operators recovered and returned the canisters, along with the Chain of Custody (COC) forms and all associated documentation, to the ERG laboratory for analysis.

By analyzing each sample with gas chromatography incorporating mass spectrometry (operating in the Selected Ion Monitoring (SIM) mode) and flame ionization detection (GC/MS-FID), laboratory staff determined ambient air concentrations of 59 VOCs and/or 80 SNMOCs, and calculated the total non-methane organic compounds (TNMOC) concentration. TNMOC is the sum of all hydrocarbon concentrations within the sample. Because *m*-xylene and *p*-xylene elute from the GC column at the same time, both the VOC and SNMOC analytical methods report only the sum concentration for these two isomers, and not the separate concentration for each isomer. Raw data for both methods are presented in Appendices B and C.

Table 2-3 presents the experimentally-determined detection limits for the VOC target pollutants for 2015 and 2016 using Method TO-15. VOC detection limits are expressed in parts per billion volume (ppbv). Table 2-4 presents the experimentally-determined detection limits for the SNMOC target pollutants for 2015 and 2016. SNMOC detection limits are expressed in parts per billion Carbon (ppbC).

Table 2-3. 2015-2016 VOC Method Detection Limits

Pollutant	2015 MDL (ppbv	2016 MDL (ppbv)	Pollutant	2015 MDL (ppbv)	2016 MDL (ppbv)
Acetonitrile	0.031	0.051	Dichloromethane	0.019	0.021
Acetylene	0.020	0.029	1,2-Dichloropropane	0.017	0.019
Acrolein	0.030	0.120	*cis*-1,3-Dichloropropene	0.017	0.020
Acrylonitrile	0.017	0.030	*trans*-1,3-Dichloropropene	0.021	0.027
tert-Amyl Methyl Ether	0.009	0.017	Dichlorotetrafluoroethane	0.019	0.031
Benzene	0.039	0.021	Ethyl Acrylate	0.011	0.027
Bromochloromethane	0.015	0.013	Ethyl *tert*-Butyl Ether	0.008	0.012
Bromodichloromethane	0.019	0.019	Ethylbenzene	0.019	0.019
Bromoform	0.017	0.024	Hexachloro-1,3-Butadiene	0.034	0.042
Bromomethane	0.009	0.025	Methyl Isobutyl Ketone	0.014	0.022
1,3-Butadiene	0.014	0.026	Methyl Methacrylate	0.028	0.027
Carbon Disulfide	0.012	0.020	Methyl *tert*-Butyl Ether	0.014	0.009
Carbon Tetrachloride	0.010	0.017	*n*-Octane	0.017	0.018
Chlorobenzene	0.018	0.020	Propylene	0.032	0.054
Chloroethane	0.009	0.029	Styrene	0.016	0.021
Chloroform	0.016	0.012	1,1,2,2-Tetrachloroethane	0.018	0.030
Chloromethane	0.011	0.034	Tetrachloroethylene	0.014	0.016
Chloroprene	0.012	0.010	Toluene	0.018	0.017
Dibromochloromethane	0.013	0.021	1,2,4-Trichlorobenzene	0.050	0.035
1,2-Dibromoethane	0.017	0.021	1,1,1-Trichloroethane	0.013	0.015
m-Dichlorobenzene	0.025	0.024	1,1,2-Trichloroethane	0.017	0.020
o-Dichlorobenzene	0.025	0.027	Trichloroethylene	0.017	0.017
p-Dichlorobenzene	0.026	0.023	Trichlorofluoromethane	0.008	0.020
Dichlorodifluoromethane	0.008	0.0202	Trichlorotrifluoroethane	0.009	0.017
1,1-Dichloroethane	0.015	0.013	1,2,4-Trimethylbenzene	0.021	0.024
1,2-Dichloroethane	0.013	0.013	1,3,5-Trimethylbenzene	0.021	0.023
1,1-Dichloroethene	0.007	0.023	Vinyl Chloride	0.008	0.032
cis-1,2-Dichloroethylene	0.014	0.014	*m,p*-Xylene[1]	0.028	0.040
trans-1,2-Dichloroethylene	0.012	0.013	*o*-Xylene	0.016	0.020

[1] The VOC analytical method reports the sum concentration for *m*-xylene and *p*-xylene because these isomers elute from the GC column at the same time.

Table 2-4. 2015-2016 SNMOC Method Detection Limits[1]

Pollutant	2015 MDL (ppbC)	2016 MDL (ppbC)	Pollutant	2015 MDL (ppbC)	2016 MDL (ppbC)	Pollutant	2015 MDL (ppbC)	2016 MDL (ppbC)
Acetylene	0.086	0.027	*n*-Heptane	0.108	0.080	1-Octene	0.188	0.096
Benzene	0.083	0.096	1-Heptene	0.094	0.098	*n*-Pentane	0.109	0.053
1,3-Butadiene	0.109	0.123	*n*-Hexane	0.124	0.074	1-Pentene	0.084	0.048
n-Butane	0.123	0.061	1-Hexene	0.105	0.052	*cis*-2-Pentene	0.085	0.024
1-Butene	0.101	0.059	*cis*-2-Hexene	0.067	0.071	*trans*-2-Pentene	0.080	0.045
cis-2-Butene	0.060	0.025	*trans*-2-Hexene	0.074	0.069	*a*-Pinene	0.208	0.154
trans-2-Butene	0.071	0.027	Isobutane	0.125	0.039	*b*-Pinene	1.033	0.527
Cyclohexane	0.108	0.116	Isobutylene	0.124	0.052	Propane	0.256	0.122
Cyclopentane	0.095	0.074	Isopentane	0.116	0.033	*n*-Propylbenzene	0.144	0.090
Cyclopentene	0.548	0.014	Isoprene	0.110	0.033	Propylene	0.163	0.090
n-Decane	0.971	0.175	Isopropylbenzene	0.147	0.088	Propyne	0.039	0.021
1-Decene	0.381	0.382	2-Methyl-1-Butene	0.119	0.108	Styrene	0.803	0.756
m-Diethylbenzene	0.253	0.336	3-Methyl-1-Butene	0.170	0.337	Toluene	0.130	0.093
p-Diethylbenzene	0.194	0.257	2-Methyl-1-Pentene	0.126	0.070	*n*-Tridecane	0.329	0.542
2,2-Dimethylbutane	0.128	0.030	4-Methyl-1-Pentene	0.094	0.060	1-Tridecene	0.449	0.376
2,3-Dimethylbutane	0.098	0.019	2-Methyl-2-Butene	0.108	0.061	1,2,3-Trimethylbenzene	0.222	0.198
2,3-Dimethylpentane	0.141	0.046	Methylcyclohexane	0.112	0.049	1,2,4-Trimethylbenzene	0.381	0.382
2,4-Dimethylpentane	0.137	0.054	Methylcyclopentane	0.097	0.066	1,3,5-Trimethylbenzene	0.228	0.141
n-Dodecane	0.228	0.789	2-Methylheptane	0.199	0.126	2,2,3-Trimethylpentane	0.131	0.053
1-Dodecene	0.804	1.005	3-Methylheptane	0.120	0.076	2,2,4-Trimethylpentane	0.122	0.078
Ethane	0.352	0.189	2-Methylhexane	0.291	0.262	2,3,4-Trimethylpentane	0.130	0.090
2-Ethyl-1-butene	0.094	0.080	3-Methylhexane	0.553	0.224	*n*-Undecane	0.241	0.446
Ethylbenzene	0.157	0.093	2-Methylpentane	0.220	0.105	1-Undecene	0.269	0.620
Ethylene	0.170	0.153	3-Methylpentane	0.093	0.043	*m*-Xylene/*p*-Xylene[2]	0.196	0.152
m-Ethyltoluene	0.212	0.124	*n*-Nonane	0.304	0.080	*o*-Xylene	0.127	0.084
o-Ethyltoluene	0.213	0.164	1-Nonene	0.143	0.087	Sum of Knowns, Sun of Unknowns, and TNMOC have no applicable MDLs		
p-Ethyltoluene	0.148	0.141	*n*-Octane	0.264	0.082			

[1] Concentration in ppbC = concentration in ppbv * number of carbon atoms in the compound.

[2] The SNMOC analytical method reports the sum concentration for *m*-xylene and *p*-xylene because these isomers elute from the GC column at the same time.

Methane sampling and analysis was performed with a vacuum well interface attached to a gas chromatograph using methodology based on SAE J1151: Methane Measurement Using Gas Chromatography (SAE, 2011). Ambient air samples for methane analysis were collected in passivated stainless steel canisters. The ERG laboratory distributed the prepared canisters (i.e., cleaned and evacuated) to the monitoring sites before each scheduled sample collection event, and site operators connected the canisters to air sampling equipment prior to each sample day. Prior to field sampling, the passivated canisters had internal pressures much lower than atmospheric pressure. Using this pressure differential, ambient air flowed into the canisters automatically once an associated system solenoid valve was opened. A mass flow controller on the sampling device inlet ensured that ambient air entered the canister at an integrated constant rate across the collection period. At the end of the 24-hour sampling period, the solenoid valve automatically closed and stopped ambient air from flowing into the canister. Site operators recovered and returned the canisters, along with the COC forms and all associated documentation, to the ERG laboratory for analysis.

By analyzing each sample with gas chromatography incorporating flame ionization detection (GC-FID), laboratory staff determined ambient air concentrations of methane. Because of the use of a vacuum well, the pressure of each sample must be taken immediately prior to analysis and used as a correction factor for the final result. Methane samples were collected at two sites in 2015 and 2016, BROK and NROK, as part of a special study. Raw data for methane are presented in Appendix D.

Table 2-5 presents the 2015 and 2016 MDLs for the laboratory analysis of methane samples. Methane detection limits are expressed in parts per million Carbon (ppmC).

Table 2-5. 2015-2016 Methane Method Detection Limit

Pollutant	2015 MDL (ppmC)	2016 MDL (ppmC)
Methane	0.104	0.101

2.2.2 Carbonyl Compound Sampling and Analytical Method

Sampling and analysis for carbonyl compounds was performed using methodology based on EPA Compendium Method TO-11A (EPA, 1999b). Ambient air samples for carbonyl compound analysis were collected by passing ambient air through an ozone scrubber and then through cartridges containing silica gel coated with 2,4-dinitrophenylhydrazine (DNPH), a compound known to react selectively and reversibly with many aldehydes and ketones. Carbonyl compounds in ambient air are retained in the sampling cartridge, while other compounds pass through without reacting with the DNPH-coated matrix. The ERG laboratory distributed the DNPH cartridges to the monitoring sites prior to each scheduled sample collection event and site operators connected the cartridges to the air sampling equipment. After each 24-hour sampling period, site operators recovered the cartridges and returned them, along with the COC forms and all associated documentation, to the ERG laboratory for analysis.

To quantify concentrations of carbonyl compounds in the sampled ambient air, laboratory analysts extracted the exposed DNPH cartridges with acetonitrile. High-performance liquid chromatography (HPLC) analysis and ultraviolet (UV) detection of these solutions determined the relative amounts of individual carbonyl compounds present in the original air sample. Because the three tolualdehyde isomers co-elute from the HPLC column, only the sum concentration for these isomers, and not the separate concentrations for each isomer, are reported. Raw data for Method TO-11A are presented in Appendix E.

Table 2-6 presents the experimentally-determined detection limits for the carbonyl compound target pollutants for 2015 and 2016. Detection limits for carbonyl compounds are expressed in ppbv.

Table 2-6. 2015-2016 Carbonyl Compound Method Detection Limits[1]

Pollutant	2015 MDL (ppbv)	2016 MDL (ppbv)
Acetaldehyde	0.006	0.006
Acetone	0.013	0.053
Benzaldehyde	0.003	0.004
2-Butanone	0.003	0.005
Butyraldehyde	0.003	0.006
Crotonaldehyde	0.006	0.004
2,5-Dimethylbenzaldehyde	0.002	0.003
Formaldehyde	0.012	0.010
Hexaldehyde	0.002	0.005
Isovaleraldehyde	0.004	0.003
Propionaldehyde	0.003	0.004
Tolualdehydes[2]	0.004	0.008
Valeraldehyde	0.002	0.004

[1] Assumes a volume of 1,000 m^3.
[2] The three tolualdehyde isomers elute from the HPLC column at the same time; thus, the analytical method reports only the sum concentration for these three isomers and not the individual concentrations.

2.2.3 PAH Sampling and Analytical Method

PAH sampling and analysis was performed using methodology based on EPA Compendium Method TO-13A (EPA, 1999c) and ASTM D6209 (ASTM, 2013). The ERG laboratory prepared sampling media and supplied them to the sites before each scheduled sample collection event. The clean sampling PUF/XAD-2® cartridge and glass fiber filter were installed in a high volume collection system for a 24-hour sampling period. Sample collection modules, COC forms, and all associated documentation were returned to the ERG laboratory after sample collection. Within 14 days of sampling, the filter and cartridge are extracted together using a toluene in hexane solution using the Dionex Accelerated Solvent Extractor (ASE) 350 or ASE 300. The sample extract is concentrated to a final volume of 1.0 milliliter (mL). A volume of 0.6 microliter (μL) is injected into the GC/MS operating in the SIM mode to analyze for 22 PAHs. Raw data for Method TO-13A are presented in Appendix F.

Table 2-7 presents the experimentally-determined detection limits for the 22 PAH target pollutants for 2015 and 2016. PAH detection limits are expressed in nanograms per cubic meter (ng/m^3).

Table 2-7. 2015-2016 PAH Method Detection Limits[1]

Pollutant	2015 MDL (ng/m^3)	2016 MDL (ng/m^3)
Acenaphthene	0.082	0.047
Acenaphthylene	0.067	0.015
Anthracene	0.072	0.076
Benzo(a)anthracene	0.082	0.060
Benzo(a)pyrene	0.132	0.063
Benzo(b)fluoranthene	0.092	0.074
Benzo(e)pyrene	0.096	0.046
Benzo(g,h,i)perylene	0.068	0.042
Benzo(k)fluoranthene	0.098	0.059
Chrysene	0.069	0.074
Coronene	0.095	0.008
Cyclopenta[cd]pyrene	0.125	0.006
Dibenz(a,h)anthracene	0.089	0.017
Fluoranthene	0.098	0.114
Fluorene	0.189	0.113
9-Fluorenone	0.132	0.025
Indeno(1,2,3-cd)pyrene	0.083	0.045
Naphthalene	0.166	0.791
Perylene	0.065	0.013
Phenanthrene	0.156	0.066
Pyrene	0.090	0.094
Retene	0.093	0.083

[1] Assumes a volume of 300 m^3.

2.2.4 Metals Sampling and Analytical Method

Ambient air samples for metals analysis were collected by passing ambient air through either 47mm Teflon® filters or 8" x 10" quartz filters, depending on the separate and distinct sampling apparatus used to collect the sample; the 47mm Teflon® filter is used for low-volume collection systems, whereas the 8" x 10" quartz filter is used for high-volume collection systems. EPA provided the filters to the monitoring sites. Sites sampled for either particulate matter less than 10 microns (PM_{10}) or total suspended particulate (TSP). Particulates in ambient air were collected on the filters and, after a 24-hour sampling period, site operators recovered and sent the filters, along with the COC forms and all associated documentation, to the ERG laboratory for analysis.

Extraction and analysis for the determination of speciated metals in or on particulate matter was performed using a combination of EPA Compendium Method IO-3.5 and EPA FEM Methods EQL-0512-201 and EQL-0512-202 (EPA, 1999d; EPA, 2012). Upon receipt at the laboratory, whole filters (47mm Teflon®) or filter strips (8" x 10" quartz) were digested using a dilute nitric acid, hydrochloric acid, hydrogen peroxide and/or hydrofluoric acid (Teflon® only) solution. The digestate was then quantified using ICP-MS to determine the concentration of individual metals present in the original air sample. Raw data for speciated metals are presented in Appendix G.

Table 2-8 presents the experimentally-determined detection limits for metals samples for 2015 and 2016, as reported by the ERG laboratory. Due to the difference in sample volume/filter collection media, there are two sets of MDLs listed in Table 2-8, one for each filter type.

Table 2-8. 2015-2016 Metals Method Detection Limits

Pollutant	2015 MDL (ng/m^3)	2016 MDL (ng/m^3)	Pollutant	2015 MDL (ng/m^3)	2016 MDL (ng/m^3)
47mm Teflon®[1]			**8x10" Quartz[2]**		
Antimony	0.041	0.017	Antimony	0.012	0.114
Arsenic	0.153	0.039	Arsenic	0.057	0.013
Beryllium	0.017	0.001	Beryllium	0.002	0.0005
Cadmium	0.011	0.002	Cadmium	0.006	0.006
Chromium	12.0	4.18	Chromium	2.56	1.74
Cobalt	0.012	0.097	Cobalt	0.043	0.058
Lead	0.039	0.034	Lead	0.113	0.150
Manganese	0.127	0.143	Manganese	0.218	0.446
Mercury	0.036	0.017	Mercury	0.006	0.006
Nickel	0.286	0.204	Nickel	0.572	0.479
Selenium	0.292	0.054	Selenium	0.031	0.012

[1]Assumes a volume of 24.04 m^3.
[2] Assumes a volume of 2,000 m^3.

2.2.5 Hexavalent Chromium Sampling and Analytical Method

Hexavalent chromium was measured using the method described in ASTM D7614 (ASTM, 2012). Ambient air samples of hexavalent chromium from TSP were collected by passing ambient air through sodium bicarbonate impregnated acid-washed cellulose filters. ERG prepared and distributed the filters secured in Teflon® cartridges or in petri dishes, per the specific collection system used at each site, to the monitoring sites prior to each scheduled sample collection event. Site operators connected the cartridges (or installed the filters) to the air sampling equipment. After a 24-hour sampling period, site operators recovered the cartridges (or filters) and returned them, along with the COC forms and all associated documentation, to the ERG laboratory for analysis. Upon receipt at the laboratory, the filters were extracted using a sodium bicarbonate solution. Ion chromatography (IC) analysis using Ultraviolet-Visible detection of the extracts determined the amount of hexavalent chromium present in each sample. Raw data for the hexavalent chromium method are presented in Appendix H.

Table 2-9 presents the experimentally-determined detection limit for hexavalent chromium samples for 2015 and 2016, as reported by the ERG laboratory, which are expressed in ng/m^3.

Table 2-9. 2015-2016 Hexavalent Chromium Method Detection Limits[1]

Pollutant	2015 MDL (ng/m^3)	2016 MDL (ng/m^3)
Hexavalent Chromium	0.0038	0.0037

[1] Assumes a volume of 21.6 m^3.

2.3 Sample Collection Schedules

Table 2-10 presents the first and last date upon which sample collection occurred for each monitoring site sampling under the NMP in 2015. Table 2-11 presents similar information for the 2016 sampling year. The first sample date for each site is generally at the beginning of January and sampling continued through the end of December, although there are exceptions, including:

- Concurrent VOC and SNMOC sampling was initiated at RFCO at the beginning of 2015. VOC sampling was discontinued in September 2015.
- Sampling at BMCO was discontinued at the beginning of February 2015. The instrumentation was redeployed at GSCO within a week's time, where sampling reconvened and continued for just over one year. The instrumentation was returned to BMCO in mid-March 2016, where sampling resumed.

- The state of Oklahoma initiated two new monitoring sites, one in Bradley, Oklahoma (BROK) in April 2015 and a near-road site in Oklahoma City, Oklahoma (NROK) in May 2016. Methane samples were collected at these sites on the same schedule as the other pollutant groups sampled for at these locations.

- Sampling at the site in Roxana, Illinois (ROIL) was discontinued at the end of July 2015, after completing a 3-year monitoring study.

- The instrumentation at one of the UATMP's longest running sites, NBNJ, was moved to a new location, NRNJ, at the beginning of 2016. The new location is less than a mile from the old location.

- Sampling at two long-term Orange County, Florida sites (PAFL and ORFL) was discontinued at the end of September 2016.

- Hexavalent chromium sampling was discontinued at RIVA at the end of June 2016.

- VOC sampling was discontinued at LEKY at the end of July 2016.

According to the NMP schedule, 24-hour integrated samples were collected at each monitoring site on a 1-in-6 day schedule and sample collection began and ended at midnight, local standard time. However, there were some exceptions, as some sites collected samples on a 1-in-12 day schedule, dependent upon location and monitoring objectives. The sites sampling on a 1-in-12 day schedule are denoted in Tables 2-10 and 2-11 and include:

- SNMOC samples were collected on a 1-in-6 day schedule while carbonyl compounds were collected on a 1-in-12 day schedule at BMCO, BRCO, GSCO, PACO, and RICO. Sampling at RFCO was conducted on a 1-in-12 day schedule for both VOCs and SNMOCs.

- The South Phoenix, Arizona site (SPAZ) collected VOC samples on a 1-in-12 day schedule.

- The Orlando, Florida site (PAFL) collected metals samples on a 1-in-12 day schedule.

Table 2-10. 2015 Sampling Schedules and Completeness Rates

Site	Monitoring Period[1]		Carbonyl Compounds			VOCs			Hexavalent Chromium			Metals			SNMOCs			PAHs		
	First Sample	Last Sample	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
ASKY	1/6/15	12/26/15	--	--	--	60	60	100	--	--	--	--	--	--	--	--	--	--	--	--
ASKY-M	1/6/15	12/26/15	--	--	--	--	--	--	--	--	--	55	60	92	--	--	--	--	--	--
ATKY	1/6/15	12/26/15	--	--	--	59	60	98	--	--	--	--	--	--	--	--	--	--	--	--
AZFL	1/6/15	12/26/15	58	60	97	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BAKY	1/6/15	12/26/15	--	--	--	--	--	--	--	--	--	56	60	93	--	--	--	--	--	--
BLKY	1/6/15	12/26/15	--	--	--	59	60	98	--	--	--	51	60	85	--	--	--	--	--	--
BMCO	1/6/15	2/5/15	3	3	100[2]	--	--	--	--	--	--	--	--	--	6	6	100	--	--	--
BOMA	1/6/15	12/26/15	--	--	--	--	--	--	--	--	--	60	60	100	--	--	--	60	60	100
BRCO	1/6/15	12/26/15	28	30	93[2]	--	--	--	--	--	--	--	--	--	52	60	87	--	--	--
BROK[3]	4/12/15	12/26/15	40	44	91	39	44	89	--	--	--	--	--	--	39	44	89	--	--	--
BTUT	1/6/15	12/26/15	54	60	90	50	60	83	--	--	--	60	60	100	49	60	82	56	60	93
BXNY	1/6/15	12/26/15	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	59	60	98
CELA	1/6/15	12/26/15	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	57	60	95
CHNJ	1/6/15	12/26/15	34	60	57	55	60	92	--	--	--	--	--	--	--	--	--	--	--	--
CSNJ	1/6/15	12/26/15	59	60	98	61	60	>100	--	--	--	--	--	--	--	--	--	--	--	--

A = Number of valid samples collected.
B = Number of valid samples that should be collected in 2015 based on sample schedule and start/end date of sampling.
C = Completeness (%).
[1] Begins with first sample collected and ends with last sample collected; date range presented may not be representative of each method-specific date range.
[2] Sampling schedule was a 1-in-12 day schedule rather than a 1-in-6 schedule.
[3] Methane samples were also collected at this site and will be discussed in later sections.
BOLD ITALICS = EPA-designated NATTS site.
Orange shading indicates that completeness is less than the MQO of 85 percent.

Table 2-10. 2015 Sampling Schedules and Completeness Rates (Continued)

Site	Monitoring Period[1]		Carbonyl Compounds			VOCs			Hexavalent Chromium			Metals			SNMOCs			PAHs		
	First Sample	Last Sample	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
DEMI	1/6/15	12/26/15	60	60	100	60	60	100	--	--	--	--	--	--	--	--	--	62	60	>100
ELNJ	1/6/15	12/26/15	60	60	100	60	60	100	--	--	--	--	--	--	--	--	--	--	--	--
GLKY	1/6/15	12/26/15	60	60	100	60	60	100	--	--	--	58	60	97	--	--	--	59	60	98
GPCO	1/6/15	12/28/15	55	60	92	50	60	83	--	--	--	57	60	95	--	--	--	55	60	92
GSCO	2/11/15	12/26/15	26	27	96	--	--	--	--	--	--	--	--	--	52	54	96	--	--	--
INDEM	1/6/15	12/26/15	60	60	100	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
LEKY	1/6/15	12/26/15	--	--	--	53	60	88	--	--	--	56	60	93	--	--	--	--	--	--
NBIL	1/6/15	12/26/15	57	60	95	54	60	90	--	--	--	56	60	93	54	60	90	60	60	100
NBNJ	1/6/15	12/26/15	59	60	98	59	60	98	--	--	--	--	--	--	--	--	--	--	--	--
OCOK	1/6/15	12/26/15	60	60	100	60	60	100	--	--	--	60	60	100	--	--	--	--	--	--
ORFL	1/6/15	12/26/15	58	60	97	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
PACO	1/6/15	12/26/15	18	30	60[2]	--	--	--	--	--	--	--	--	--	54	60	90	--	--	--
PAFL[2]	1/12/15	12/26/15	--	--	--	--	--	--	--	--	--	30	30	100	--	--	--	--	--	--
PRRI	1/6/15	12/26/15	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	60	60	100
PXSS	1/6/15	12/26/15	33	60	55	58	60	97	--	--	--	59	60	98	--	--	--	55	60	92

A = Number of valid samples collected.
B = Number of valid samples that should be collected in 2015 based on sample schedule and start/end date of sampling.
C = Completeness (%).
[1] Begins with first sample collected and ends with last sample collected; date range presented may not be representative of each method-specific date range.
[2] Sampling schedule was a 1-in-12 day schedule rather than a 1-in-6 schedule.
[3] Methane samples were also collected at this site and will be discussed in later sections.
BOLD ITALICS = EPA-designated NATTS site.
Orange shading indicates that completeness is less than the MQO of 85 percent.

Table 2-10. 2015 Sampling Schedules and Completeness Rates (Continued)

Site	Monitoring Period[1]		Carbonyl Compounds			VOCs			Hexavalent Chromium			Metals			SNMOCs			PAHs		
	First Sample	Last Sample	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
RFCO[2]	1/6/15	12/26/15	--	--	--	20	22	91	--	--	--	--	--	--	26	30	87	--	--	--
RICO	1/6/15	12/26/15	26	30	87[2]	--	--	--	--	--	--	--	--	--	46	60	77	--	--	--
RIVA	1/6/15	12/26/15	--	--	--	--	--	--	59	60	98	--	--	--	--	--	--	56	60	93
ROCH	1/6/15	12/26/15	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	56	60	93
ROIL	1/6/15	7/29/15	33	35	94	32	35	91	--	--	--	--	--	--	--	--	--	--	--	--
RUCA	1/6/15	12/26/15	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	59	60	98
S4MO	1/6/15	12/26/15	60	60	100	60	60	100	--	--	--	60	60	100	--	--	--	58	60	97
SEWA	1/6/15	12/26/15	59	60	98	57	60	95	--	--	--	58	60	97	--	--	--	57	60	95
SJJCA	1/6/15	12/26/15	--	--	--	--	--	--	--	--	--	59	60	98	--	--	--	58	60	97
SKFL	1/6/15	12/26/15	58	60	97	--	--	--	--	--	--	--	--	--	--	--	--	59	60	98
SPAZ[2]	1/6/15	12/26/15	--	--	--	32	30	>100	--	--	--	--	--	--	--	--	--	--	--	--
SPIL	1/6/15	12/26/15	61	60	>100	60	60	100	--	--	--	--	--	--	--	--	--	--	--	--
SYFL	1/6/15	12/26/15	57	60	95	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
TMOK	1/6/15	12/26/15	60	60	100	60	60	100	--	--	--	59	60	98	--	--	--	--	--	--
TOOK	1/6/15	12/26/15	60	60	100	59	60	98	--	--	--	60	60	100	--	--	--	--	--	--

A = Number of valid samples collected.
B = Number of valid samples that should be collected in 2015 based on sample schedule and start/end date of sampling.
C = Completeness (%).
[1] Begins with first sample collected and ends with last sample collected; date range presented may not be representative of each method-specific date range.
[2] Sampling schedule was a 1-in-12 day schedule rather than a 1-in-6 schedule.
[3] Methane samples were also collected at this site and will be discussed in later sections.
BOLD ITALICS = EPA-designated NATTS site.
Orange shading indicates that completeness is less than the MQO of 85 percent.

Table 2-10. 2015 Sampling Schedules and Completeness Rates (Continued)

Site	Monitoring Period[1]		Carbonyl Compounds			VOCs			Hexavalent Chromium			Metals			SNMOCs			PAHs		
	First Sample	Last Sample	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
TROK	1/6/15	12/26/15	59	60	98	60	60	100	--	--	--	60	60	100	--	--	--	--	--	--
TVKY	1/6/15	12/26/15	--	--	--	62	60	>100	--	--	--	--	--	--	--	--	--	--	--	--
UNVT	1/6/15	12/26/15	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	60	60	100
WADC	1/6/15	12/26/15	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	60	60	100
WPIN	1/6/15	12/26/15	59	60	98	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
YUOK	1/6/15	12/26/15	59	60	98	59	60	98	--	--	--	59	60	98	--	--	--	--	--	--
Total			1,533	1,639	94	1,458	1,511	96	59	60	98	1,073	1,110	97	378	434	87	1,106	1,140	97

A = Number of valid samples collected.
B = Number of valid samples that should be collected in 2015 based on sample schedule and start/end date of sampling.
C = Completeness (%).
[1] Begins with first sample collected and ends with last sample collected; date range presented may not be representative of each method-specific date range.
[2] Sampling schedule was a 1-in-12 day schedule rather than a 1-in-6 schedule.
[3] Methane samples were also collected at this site and will be discussed in later sections.
BOLD ITALICS = EPA-designated NATTS site.
Orange shading indicates that completeness is less than the MQO of 85 percent.

Table 2-11. 2016 Sampling Schedules and Completeness Rates

Site	Monitoring Period[1]		Carbonyl Compounds			VOCs			Hexavalent Chromium			Metals			SNMOCs			PAHs		
	First Sample	Last Sample	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
ASKY	1/1/16	12/26/16	--	--	--	60	61	98	--	--	--	--	--	--	--	--	--	--	--	--
ASKY-M	1/1/16	12/26/16	--	--	--	--	--	--	--	--	--	55	61	90	--	--	--	--	--	--
ATKY	1/1/16	12/26/16	--	--	--	61	61	100	--	--	--	--	--	--	--	--	--	--	--	--
AZFL	1/1/16	12/26/16	61	61	100	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BAKY	1/1/16	12/26/16	--	--	--	--	--	--	--	--	--	58	61	95	--	--	--	--	--	--
BLKY	1/1/16	12/26/16	--	--	--	60	61	98	--	--	--	59	61	97	--	--	--	--	--	--
BMCO	3/13/16	12/26/16	24	24	100[2]	--	--	--	--	--	--	--	--	--	48	49	98	--	--	--
BOMA	1/1/16	12/26/16	--	--	--	--	--	--	--	--	--	58	61	95	--	--	--	61	61	100
BRCO	1/1/16	12/26/16	26	30	87[2]	--	--	--	--	--	--	--	--	--	58	61	95	--	--	--
BROK[3]	1/1/16	12/26/16	60	61	98	59	61	97	--	--	--	--	--	--	59	61	97	--	--	--
BTUT	1/1/16	12/26/16	59	61	97	59	61	97	--	--	--	55	61	90	59	61	97	61	61	100
BXNY	1/1/16	12/26/16	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	61	61	100
CELA	1/1/16	12/26/16	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	61	61	100
CHNJ	1/1/16	12/26/16	60	61	98	58	61	95	--	--	--	--	--	--	--	--	--	--	--	--
CSNJ	1/1/16	12/26/16	60	61	98	55	61	90	--	--	--	--	--	--	--	--	--	--	--	--

A = Number of valid samples collected.
B = Number of valid samples that should be collected in 2016 based on sample schedule and start/end date of sampling.
C = Completeness (%).
[1] Begins with first sample collected and ends with last sample collected; date range presented may not be representative of each method-specific date range.
[2] Sampling schedule was a 1-in-12 day schedule rather than a 1-in-6 schedule.
[3] Methane samples were also collected at this site and will be discussed in later sections.
BOLD ITALICS = EPA-designated NATTS site.
Orange shading indicates that completeness is less than the MQO of 85 percent.

Table 2-11. 2016 Sampling Schedules and Completeness Rates (Continued)

Site	Monitoring Period[1]		Carbonyl Compounds			VOCs			Hexavalent Chromium			Metals			SNMOCs			PAHs		
	First Sample	Last Sample	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
DEMI	1/1/16	12/26/16	61	61	100	60	61	98	--	--	--	--	--	--	--	--	--	61	61	100
ELNJ	1/1/16	12/26/16	61	61	100	60	61	98	--	--	--	--	--	--	--	--	--	--	--	--
GLKY	1/1/16	12/26/16	61	61	100	61	61	100	--	--	--	59	61	97	--	--	--	61	61	100
GPCO	1/1/16	12/26/16	59	61	97	62	61	>100	--	--	--	60	61	98	--	--	--	61	61	100
GSCO	1/1/16	3/7/16	5	6	83	--	--	--	--	--	--	--	--	--	12	12	100	--	--	--
INDEM	1/1/16	12/26/16	59	61	97	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
LEKY	1/1/16	12/26/16	--	--	--	29	36	81	--	--	--	47	61	77	--	--	--	--	--	--
NBIL	1/1/16	12/26/16	59	61	97	59	61	97	--	--	--	57	61	93	59	61	97	56	61	92
NRNJ	1/1/16	12/26/16	60	61	98	60	61	98	--	--	--	--	--	--	--	--	--	--	--	--
NROK[3]	5/18/16	12/26/16	38	38	100	38	38	100	--	--	--	--	--	--	38	38	100	--	--	--
OCOK	1/1/16	12/26/16	60	61	98	61	61	100	--	--	--	60	61	98	--	--	--	--	--	--
ORFL	1/1/16	9/27/16	41	46	89	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
PACO	1/7/16	12/26/16	29	30	97[2]	--	--	--	--	--	--	--	--	--	54	61	89	--	--	--
PAFL[2]	1/1/16	9/27/16	--	--	--	--	--	--	--	--	--	24	23	>100	--	--	--	--	--	--
PRRI	1/1/16	12/26/16	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	60	61	98

A = Number of valid samples collected.
B = Number of valid samples that should be collected in 2016 based on sample schedule and start/end date of sampling.
C = Completeness (%).
[1] Begins with first sample collected and ends with last sample collected; date range presented may not be representative of each method-specific date range.
[2] Sampling schedule was a 1-in-12 day schedule rather than a 1-in-6 schedule.
[3] Methane samples were also collected at this site and will be discussed in later sections.
BOLD ITALICS = EPA-designated NATTS site.
Orange shading indicates that completeness is less than the MQO of 85 percent.

Table 2-11. 2016 Sampling Schedules and Completeness Rates (Continued)

Site	Monitoring Period[1]		Carbonyl Compounds			VOCs			Hexavalent Chromium			Metals			SNMOCs			PAHs		
	First Sample	Last Sample	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
PXSS	1/1/16	12/29/16	58	61	95	60	61	98	--	--	--	61	61	100	--	--	--	51	61	84
RFCO[2]	1/7/16	12/20/16	--	--	--	--	--	--	--	--	--	--	--	--	27	30	90	--	--	--
RICO	1/7/16	12/26/16	30	30	100[2]	--	--	--	--	--	--	--	--	--	62	61	>100	--	--	--
RIVA	1/1/16	12/26/16	--	--	--	--	--	--	27	31	87	--	--	--	--	--	--	60	61	98
ROCH	1/1/16	12/26/16	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	60	61	98
RUCA	1/1/16	12/26/16	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	59	61	97
S4MO	1/1/16	12/26/16	60	61	98	60	61	98	--	--	--	61	61	100	--	--	--	60	61	98
SEWA	1/1/16	12/26/16	61	61	100	61	61	100	--	--	--	58	61	95	--	--	--	61	61	100
SJJCA	1/1/16	12/26/16	--	--	--	--	--	--	--	--	--	57	61	93	--	--	--	61	61	100
SKFL	1/1/16	12/28/16	59	61	97	--	--	--	--	--	--	--	--	--	--	--	--	59	61	97
SPAZ[2]	1/1/16	12/26/16	--	--	--	31	31	100	--	--	--	--	--	--	--	--	--	--	--	--
SPIL	1/1/16	12/26/16	57	61	93	58	61	95	--	--	--	--	--	--	--	--	--	--	--	--
SYFL	1/1/16	12/26/16	56	61	92	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
TMOK	1/1/16	12/26/16	60	61	98	60	61	98	--	--	--	61	61	100	--	--	--	--	--	--
TOOK	1/1/16	12/26/16	61	61	100	61	61	100	--	--	--	61	61	100	--	--	--	--	--	--

A = Number of valid samples collected.
B = Number of valid samples that should be collected in 2016 based on sample schedule and start/end date of sampling.
C = Completeness (%).
[1] Begins with first sample collected and ends with last sample collected; date range presented may not be representative of each method-specific date range.
[2] Sampling schedule was a 1-in-12 day schedule rather than a 1-in-6 schedule.
[3] Methane samples were also collected at this site and will be discussed in later sections.
BOLD ITALICS = EPA-designated NATTS site.
Orange shading indicates that completeness is less than the MQO of 85 percent.

Table 2-11. 2016 Sampling Schedules and Completeness Rates (Continued)

Site	Monitoring Period[1]		Carbonyl Compounds			VOCs			Hexavalent Chromium			Metals			SNMOCs			PAHs		
	First Sample	Last Sample	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
TROK	1/1/16	12/26/16	61	61	100	61	61	100	--	--	--	61	61	100	--	--	--	--	--	--
TVKY	1/1/16	12/26/16	--	--	--	61	61	100	--	--	--	--	--	--	--	--	--	--	--	--
UNVT	1/1/16	12/26/16	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	61	61	100
WADC	1/1/16	12/26/16	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	58	61	95
WPIN	1/1/16	12/26/16	57	61	93	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
YUOK	1/1/16	12/26/16	61	61	100	61	61	100	--	--	--	61	61	100	--	--	--	--	--	--
Total			1,624	1,668	97	1,476	1,508	98	27	31	87	1,073	1,121	96	476	495	96	1,133	1,159	98

A = Number of valid samples collected.
B = Number of valid samples that should be collected in 2016 based on sample schedule and start/end date of sampling.
C = Completeness (%).
[1] Begins with first sample collected and ends with last sample collected; date range presented may not be representative of each method-specific date range.
[2] Sampling schedule was a 1-in-12 day schedule rather than a 1-in-6 schedule.
[3] Methane samples were also collected at this site and will be discussed in later sections.
BOLD ITALICS = EPA-designated NATTS site.
Orange shading indicates that completeness is less than the MQO of 85 percent.

The number of sites at which samples were collected for each method varied only slightly between 2015 and 2016, as shown in Tables 2-10 and 2-11:

- 27 sites collected VOC samples in 2015 compared to 26 sites in 2016.
- 9 sites collected SNMOC samples in 2015 compared to 10 sites in 2016.
- 31 sites collected carbonyl compound samples in both 2015 and 2016.
- 19 sites collected PAH samples in both 2015 and 2016.
- 19 sites collected metals samples in both 2015 and 2016.
- 1 site collected hexavalent chromium samples in both 2015 and 2016.
- 1 site collected methane samples in 2015 compared to 2 sites in 2016.

As part of the sampling schedule, site operators were instructed to collect duplicate (or collocated) samples on roughly 10 percent of the sample days for select methods when duplicate (or collocated) collection systems were available. Field blanks were collected once per month for carbonyl compounds, hexavalent chromium, metals, and PAHs. Sampling calendars were distributed to help site operators schedule the collection of samples, duplicates, and field blanks. In cases where a valid sample was not collected on a given scheduled sample day, site operators were instructed to reschedule or "make up" samples on other days. This practice explains why some monitoring sites periodically strayed from the 1-in-6 or 1-in-12 day sampling schedule.

The 1-in-6 or 1-in-12 day sampling schedule provides cost-effective approaches to data collection for trends characterization of toxic pollutants in ambient air and ensures that sample days are evenly distributed among the seven days of the week to allow weekday/weekend comparison of air quality. Because the 1-in-6 day schedule yields twice the number of measurements than the 1-in-12 day schedule, data characterization based on this schedule tends to be more representative.

2.4 Completeness

Completeness refers to the number of valid samples collected and analyzed compared to the number of total samples expected based on a 1-in-6 or 1-in-12 day sample schedule. Monitoring programs that consistently generate valid samples have higher completeness than programs that consistently have invalid samples. The completeness of an air monitoring program, therefore, can be a qualitative measure of the reliability of air sampling and laboratory analytical equipment as well as a measure of the competency of the field and laboratory staff

involved and the efficiency with which the program is managed. The completeness for each monitoring site and method sampled is presented in Tables 2-10 (for 2015) and 2-11 (for 2016).

The measurement quality objective (MQO) for completeness based on the EPA-approved Quality Assurance Project Plan (QAPP) specifies that at least 85 percent of samples from a given monitoring site must be collected and analyzed successfully to be considered sufficient for data trends analysis (ERG, 2015 and ERG, 2016). The data in Tables 2-10 and 2-11 show that 204 of the 215 datasets (107 from 2015 and 108 from 2016) met the 85 percent completeness MQO; 11 datasets (seven from 2015 and four from 2016) from the 2015-2016 NMP monitoring effort did not meet this MQO (orange shaded cells in Tables 2-10 and 2-11):

- BTUT VOCs and SNMOCs in 2015 - A number of invalid canister samples scattered throughout the year a completeness resulted in a completeness less than 85 percent for BTUT in 2015.

- CHNJ carbonyl compounds in 2015 – Issues with the collection system were discovered at CHNJ and resulted in the invalidation of carbonyl compound samples collected between March 31, 2015 and September 3, 2015, after which a new collection system was installed.

- GPCO VOCs in 2015 - A number of invalid VOC samples between February and April 2015, many of which were related to a shortened sampling duration, resulted in a completeness less than 85 percent for GPCO in 2015.

- PACO carbonyl compounds in 2015 - A series of carbonyl compound samples resembling field blanks were collected at PACO during the first half of 2015, resulting in the invalidation of one-third of the samples collected in 2015.

- PXSS carbonyl compounds in 2015 - An instrument contamination issue with the primary carbonyl compound collection system at PXSS resulted in the invalidation of many samples collected on the primary collection system between January and May 2015 and also between August and November 2015.

- RICO SNMOCs in 2015 - A number of SNMOC samples did not run properly at RICO in June and first part of July 2015; this combined with other invalid samples throughout the year resulted in a completeness less than 85 percent for RICO in 2015.

- GSCO carbonyl compounds in 2016 - Because the instrumentation at GSCO was moved back to BMCO in March 2016, the one invalid sample was enough to reduce the completeness to less than 85 percent for GSCO’s carbonyl compounds.

- LEKY metals and VOCs in 2016 - A number of metals samples collected at LEKY in March and April 2016 had QA-related issues according to the state of Kentucky. Operator errors combined with other invalidated samples also resulted in a VOC completeness less than 85 percent for LEKY.

- PXSS PAHs in 2016 - Issues with the collection system during late summer and early fall 2016 led to a PAH completeness less than 85 percent for PXSS.

The percent completeness for each of these datasets varies from just less than the MQO of 85 percent (between 80 percent and 85 percent for each) to 55 percent (PXSS carbonyl compounds in 2015). Appendix I identifies samples that were invalidated and lists the reason for invalidation, based on the applied AQS null code.

Also of note, a contaminated internal standard used at the laboratory for Method TO-15 resulted in unusual analytical results for hexachloro-1,3-butadiene and 1,2,4-trichlorobenzene at VOC sites sampling in 2015. It was determined that the internal standard in use was contaminated and these results were invalidated. Affected samples were collected at the end of February 2015 or early March 2015 through mid-December 2015. As this affected only two of the VOCs for which measurements were collected, this invalidation is not reflected in Table 2-10.

A second, separate contaminated internal standard was in use during the fall of 2016, and further investigation led to the correction of data for eight VOCs (bromochloromethane, chloroethane, chloromethane, dichlorodifluoromethane, dichlorotetrafluoroethane, propylene, trichlorofluoromethane, and vinyl chloride) for samples collected near the end of August 2016 or early September 2016 through the end of the year.

Method-specific completeness is presented at the bottom of Tables 2-10 and 2-11. Method specific completeness was greater than 85 percent for all methods performed under the 2015 and 2016 NMP monitoring efforts and ranged from 87.10 percent (2015 SNMOC and 2016 hexavalent chromium) to 98.33 percent (2015 hexavalent chromium).

Because methane is not an official part of the NMP, completeness is not provided for methane in Tables 2-10 and 2-11. Methane samples were collected at two sites in Oklahoma, one in 2015 (BROK) and two in 2016 (BROK and NROK). Methane completeness for BROK was 89 percent in 2015 and 93 percent in 2016; completeness for NROK was 100 percent in 2016. This yields a method completeness for methane of 89 percent in 2015 and 96 percent in 2016.

3.0 Summary of the 2015-2016 National Monitoring Programs Data Treatment and Methods for Data Analysis

This section summarizes the data treatments employed and approaches used to analyze the data generated from samples collected during the 2015-2016 NMP sampling years. These data were analyzed on a program-wide basis as well as a site-specific basis.

The 2015-2016 NMP report includes data from samples collected at monitoring sites participating under the NMP and supported by the national contract laboratory.

Results from the program-wide data analyses are presented in Section 4 while results from the site-specific data analyses are presented in the individual state sections, Sections 5 through 23.

A total of 445,119 valid air toxics concentrations (including non-detects and analyses for duplicate, replicate, and collocated samples) were produced from 15,321 valid samples collected at 53 monitoring sites during the 2015-2016 reporting years. A tabular presentation of the raw data are found in Appendices B through H and statistical summaries are presented in Appendices J through P, as shown in Table 3-1.

Table 3-1. Overview and Organization of Data Presented

Pollutant Group	Number of Sites		Appendix	
	2015	2016	Raw Data	Statistical Summary
VOCs	27	26	B	J
SNMOCs	9	10	C	K
Methane	1	2	D	L
Carbonyl Compounds	31	31	E	M
PAHs	19	19	F	N
Metals	19	19	G	O
Hexavalent Chromium	1	1	H	P

3.1 Approach to Data Treatment

This section examines the various statistical tools employed to analyze and characterize the data collected during the 2015-2016 sampling year. Certain data analyses were performed at the program-level, other data analyses were performed at both the program-level and on a site-specific basis, and still other approaches were reserved for site-specific data analyses only. Regardless of the data analysis employed, it is important to understand how the monitoring data were treated. The following paragraphs describe techniques used to prepare this large quantity of concentration data for data analysis.

Considerable care is taken to ensure that there is a single concentration for each target pollutant per site, sample date, and analytical method. In cases where a site has primary, duplicate (or collocated), and/or replicate measurements, the primary sample result is used for data analysis. For instances in which the primary sample was invalid, the duplicate or collocate results were used. This is referred to as the *preprocessed daily measurement*. This approach represents a change from past NMP reports, in which the primary, duplicate (or collocated), and replicate measurements were averaged together to obtain a preprocessed daily measurement.

Concentrations of *m,p*-xylene and *o*-xylene were summed together and are referred to as "total xylenes," or simply "xylenes" throughout the remainder of this report, with a few exceptions. One exception is Section 4.1, which examines the results of basic statistical calculations performed on the dataset. Table 4-1 and Table 4-2, which are the method-specific statistical summaries for VOCs and SNMOCs, respectively, present the xylenes results retained as *m,p*-xylene and *o*-xylene species. Data for these isomers are also presented individually in the Data Quality section (Section 24).

For the 2015-2016 NMP, where statistical parameters are calculated based on the preprocessed daily measurements, zeros have been substituted for non-detect results. This approach agrees with how data are loaded into AQS, as directedy by the NATTS TAD **(**EPA, 2009a), and is consistent with other EPA air toxics monitoring programs, such as the School Air Toxics Monitoring Program (SATMP) (EPA, 2011), and other associated reports, including the NATTS Network Assessment (EPA, 2017c). The substitution of zeros for non-detects results in lower average concentrations of pollutants that are rarely measured at or above the associated MDL and/or have a relatively high MDL.

In order to compare concentrations across multiple sampling methods, all concentrations have been converted to a common unit of measure: microgram per cubic meter ($\mu g/m^3$). However, whenever a particular sampling method is isolated from others, such as in Tables 4-1 through 4-7, the statistical parameters are presented in the unit of measure associated with the particular sampling method. Thus, it is important to pay close attention to the unit of measure associated with each data analysis discussed in this and subsequent sections of the report.

This report presents various time-based averages to summarize the measurements for a specific site. Where applicable, quarterly and annual concentration averages were calculated for each site. The *quarterly average concentration* of a particular pollutant is simply the average

concentration of the preprocessed daily measurements over a given calendar quarter. Quarterly averages include the substitution of zeros for all non-detects. Quarterly averages for the first quarter of the calendar year include measurements collected in January, February, and March; the second quarter includes April, May, and June samples; the third quarter includes July, August, and September samples; and the fourth quarter includes October, November, and December samples. A minimum of 75 percent of the total number of samples possible within a given calendar quarter must be valid to have a quarterly average presented. For sites sampling on a 1-in-6 day sampling schedule, 12 samples meet the 75 percent criteria; for sites sampling on a 1-in-12 day schedule, six samples meet the 75 percent criteria. Sites that do not meet this minimum requirement do not have a quarterly average concentration presented. Sites may not meet this minimum requirement due to invalidated or missed samples or because of a shortened sampling duration.

An *annual average concentration* includes all measured detections and substituted zeros for non-detects for a given calendar year. Annual average concentrations were calculated for monitoring sites where three quarterly averages could be calculated and where method completeness, as presented in Section 2.4, is greater than or equal to 85 percent. Sites that do not meet these requirements do not have an annual average concentration presented, although site-specific statistical summaries are provided in the Appendices of this report.

The concentration averages presented in this report are often provided with their associated 95 percent confidence intervals. Confidence intervals represent the interval within which the true average concentration falls 95 percent of the time. The confidence interval includes an equal amount of quantities less than and greater than the concentration average (EPA, 2011). For example, an average concentration may be written as 1.25 ± 0.25 µg/m^3; thus, the interval over which the true average would be expected to fall would be between 1.00 µg/m^3 and 1.50 µg/m^3.

3.2 Human Health Risk and the Pollutants of Interest

A practical approach to making an assessment on a large number of air monitoring measurements is to focus on a subset of pollutants based on the end-use of the dataset. Thus, a subset of pollutants is selected for further data analyses for each annual NMP report. Health risk-based calculations have been used to identify “pollutants of interest” for several years, including the 2015-2016 NMP report. The following paragraphs provide an overview of health risk terms

and concepts and outline how the pollutants of interest are determined and then used throughout the remainder of the report.

EPA defines risk as "the probability that damage to life, health, or the environment will occur as a result of a given hazard (such as exposure to a toxic chemical)" (EPA, 2015a). Human health risk can be further defined in terms of time. Chronic effects develop from repeated exposure over long periods of time; acute effects develop from a single exposure or from exposures over short periods of time (EPA, 2010a). Health risk is also route-specific; that is, risk varies depending upon route of exposure (i.e., oral vs. inhalation). Because this report covers air toxics in ambient air, only the inhalation route is considered.

Health risks are typically divided into cancer and noncancer effects when referring to human health risk. Cancer risk is defined as the likelihood of developing cancer as a result of exposure to a given concentration over a 70-year period, and is presented as the number of people at risk for developing cancer per million people. Noncancer health effects are those other than cancer, including conditions such as asthma. Noncancer health risks are presented as a hazard quotient (HQ), the ratio of a given concentration level and the value at which adverse health effects are not expcted. An HQ less than or equal to 1.0 indicates that adverse health effects are not expected (EPA, 2015a). Cancer risk is presented as a probability while the hazard quotient is a ratio and thus, a unitless value.

Hazardous air pollutants (HAPs) are those pollutants "known or suspected to cause cancer or other serious health effects, such as reproductive effects or birth defects, or adverse environmental effects" (EPA, 2017d). In order to assess health risk, EPA and other agencies develop toxicity factors, such as cancer unit risk estimates (UREs) and noncancer reference concentrations (RfCs), to estimate cancer and noncancer risks and to identify (or screen) where HAP concentrations may present a human health risk. EPA has published a guidance document outlining a risk-based screening approach for performing an initial screen of ambient air toxics monitoring datasets (EPA, 2010a). The *preliminary risk-based screening process* provided in this report is an adaptation of that approach and is a risk-based methodology for analysts and interested parties to identify which pollutants may pose a health risk in their area. For this process, cancer UREs and noncancer RfCs are converted into screening values. The cancer screening value is the cancer URE converted to $\mu g/m^3$ and divided by one million. The noncancer screening value is one-tenth of the noncancer RfC and converted from milligram per cubic meter (mg/m^3) to $\mu g/m^3$. The final screening value used in this report is the lower of the

two screening values. Not all pollutants analyzed under the NMP have screening values; of the pollutants sampled under the NMP, 71 pollutants have screening values. The screening values used in this data analysis are presented in Appendix Q[1].

The preprocessed daily measurements of the target pollutants were compared to these chronic risk screening values in order to identify pollutants of interest across the program. The following risk-based screening process was used to identify pollutants of interest:

1. The TO-15 and SNMOC methods have 12 pollutants in common. If a pollutant was measured by both the TO-15 and SNMOC methods at the same site, the TO-15 results were used. (This is because the TO-15 pollutants are calibrated individually whereas the SNMOC pollutants are based on propane-based response factors.) The purpose of this data treatment is to have one concentration per pollutant for each sample day. The exception to this is for RFCO. Concurrent analysis was performed for RFCO from January 2015 through September 2015, after which, only the SNMOC analysis continued. Thus, for RFCO, the SNMOC results were used over the TO-15 results for the 12 pollutants in common between the methods.

2. Each preprocessed daily measurement was compared to its associated risk screening value. Concentrations that are greater than the risk screening value are described as "failing the screen."

3. The number of failed screens was summed for each applicable pollutant.

4. The percent contribution of the number of failed screens to the total number of failed screens program-wide was calculated for each applicable pollutant.

5. The pollutants contributing to the top 95 percent of the total failed screens were identified as pollutants of interest.

In regards to Step 5 above, the actual cumulative contribution may exceed 95 percent in order to include all pollutants contributing to the minimum 95 percent criteria (refer to acenaphthene in Table 4-8 for an example). In addition, if the 95 percent cumulative criterion is reached, but the next pollutant contributed equally to the number of failed screens, that pollutant was also designated as a pollutant of interest. Results of the program-wide risk-based screening process are provided in Section 4.2.

A note regarding measurements of acetonitrile, acrylonitrile, carbon disulfide, and acrolein: acetonitrile concentrations may be artificially high (or non-existent) due to site conditions and potential cross-contamination with concurrent sampling of carbonyl compounds

[1] The risk-based screening process used in this report is an adaption of guidance from EPA Region 4's report "A Preliminary Risk-Based Screening Approach for Air Toxics Monitoring Datasets" but the screening values referenced in that report have since been updated (EPA, 2017e; EPA, 2015b; EPA, 2015c).

using Method TO-11A. Similarly, acrylonitrile and carbon disulfide concentrations may also be artificially high due to potential contamination of the collection systems using Method TO-15. Additionally, questions about the consistency and reliability of acrolein measurements have been raised during other monitoring projects, such as the SATMP (EPA, 2010b). The inclusion of acetonitrile, acrylonitrile, carbon disulfide, and acrolein in data analyses must be determined on a site-specific basis by the agency responsible for the site. Thus, results for these pollutants are excluded from program-wide and site-specific data analyses related to risk.

The NATTS TAD (EPA, 2009a) identifies 19 "MQO Core Analytes" that participating sites are required to sample and analyze for under the NATTS program. Table 3-2 presents these MQO Core Analytes. Monitoring for these pollutants is required because they are major health risk drivers according to EPA (EPA, 2009a). Many of the pollutants listed in Table 3-2 are identified as pollutants of interest via the risk-based screening process. Note that hexavalent chromium was removed from the list of required pollutants for which to sample under the NATTS program beginning in July 2013. As a result, many NATTS sites discontinued sampling hexavalent chromium. During the 2015 and 2016 sampling years, RIVA was the only NATTS site at which sampling for this pollutant continued; however, sampling for hexavalent chromium at RIVA was discontinued in June 2016.

The "pollutants of interest" designation is reserved for pollutants targeted for sampling through the NMP that meet the identified criteria. As discussed in Section 2.0, agencies operating monitoring sites that participate under the UATMP, NATTS, or CSATAM programs are not required to have their samples analyzed by ERG or may measure pollutants other than those targeted under the NMP. In these cases, data are generated by sources other than ERG and are not included in the preliminary risk-based screening process or any other data analysis contained in this report.

Table 3-2. NATTS MQO Core Analytes

Pollutant	Class/Method
Acrolein	VOCs/TO-15
Benzene	
1,3-Butadiene	
Carbon Tetrachloride	
Chloroform	
Tetrachloroethylene	
Trichloroethylene	
Vinyl Chloride	
Acetaldehyde	Carbonyl Compounds/ TO-11A
Formaldehyde	
Naphthalene	PAHs/ TO-13A
Benzo(a)pyrene	
Arsenic	Metals/ IO-3.5 and EQL-0512-201/202
Beryllium	
Cadmium	
Manganese	
Lead	
Nickel	
Hexavalent chromium[1]	Metals/ASTM D7614

[1] Hexavalent chromium was removed from the Core Analytes list in July 2013.

3.3 Additional Program-Level Data Analyses of the 2015-2016 National Monitoring Programs Dataset

This section summarizes additional data analyses performed on the 2015-2016 NMP dataset at the program level. Additional program-level analyses include a review of how concentrations vary among the sites and from quarter-to-quarter. The results of these data analyses are presented in Section 4.2.

Variability refers to the degree of difference among values in a dataset. Two types of variability are analyzed for this report. The first type of variability assessed in this report is inter-site variability. For this data analysis, the annual average concentrations for each site are plotted in the form of a bar graph for each program-wide pollutant of interest. The criteria for calculating an annual average concentration are discussed in Section 3.1 and sites that do not meet these requirements do not have an annual average concentration presented. This assessment allows the reader to visualize how concentrations varied across the sites for a particular pollutant of interest. In order to further this data analysis, the program-level average concentration for each polluant, as presented in Tables 4-1 through 4-7 in Section 4.1, is plotted against the site-specific annual

averages. This allows the reader to see how the site-specific annual averages compare to the program-level average for each pollutant. Note that the average concentrations shown for VOCs, SNMOCs, and carbonyl compounds in Tables 4-1, 4-2, and 4-4 are presented in method-specific units, but have been converted to a common unit of measurement ($\mu g/m^3$) for the purposes of this data analysis.

Quarterly variability is the second type of variability assessed in this report. The concentration data for each site were divided into the four quarters of each year, as described in Section 3.1. The completeness criteria, also described in Section 3.1, are maintained here as well. The site-specific quarterly average concentrations are illustrated by bar graphs for each program-level pollutant of interest. This data analysis allows for the potential determination of a quarterly (or seasonal) correlation with the magnitude of concentrations for a specific pollutant.

3.4 Additional Site-Specific Data Analyses

In addition to the analyses described in the preceding sections, the state-specific sections contain additional analyses that are applicable only at the local level. This section provides an overview of these analyses but does not discuss their results. Results of these site-specific data analyses are presented in the individual state-specific sections (Sections 5 through 23).

3.4.1 Site Characterization

For each site participating in the 2015-2016 NMP, a site characterization was performed. This characterization includes a review of the nearby area surrounding the monitoring site; the plotting of emissions sources surrounding the monitoring site; and providing traffic data and other characterizing information. For the 2015-2016 NMP report, the locations of point sources located near the monitoring sites were obtained from Version 1 of the 2014 NEI (EPA, 2016). Sources for other site-characterizing data are provided in the individual state sections.

3.4.2 Preliminary Risk-Based Screening and Pollutants of Interest

The preliminary risk-based screening process described in Section 3.2 and applied at the program-level was also completed for each individual monitoring site to determine site-specific pollutants of interest. Once these were determined, the time-period averages (quarterly and annual) described in Section 3.1 were calculated for each site and were used for various data analyses at the site-specific level, as described below:

- Comparison to the program-level average concentrations
- Trends analysis

- The calculation of cancer risk and noncancer hazard approximations, including the emission tracer analysis
- Risk-based emissions assessment.

3.4.2.1 Site-Specific Comparison to Program-level Average Concentrations

To better understand how an individual site's measurements compare to the program-level results, as presented in Section 4.1 in Tables 4-1 through 4-7, the site-specific and program-level concentrations are presented together graphically for each site-specific pollutant of interest identified via the risk-based screening process. This data analysis is an extension of the data analysis discussed in Section 3.3 and utilizes box and whisker plots, or simply box plots, to visually show this comparison. These box plots were created in Microsoft Excel, using the Peltier Tech Charts for Excel 3.0 utility (Peltier, 2016). Note that for sites sampling VOCs (or SNMOCs), pollutants are shown only in comparison to other sites sampling VOCs (or SNMOCs) to match the program-level averages presented in Section 4.1 in Tables 4-1 and 4-2.

The box plots used in this data analysis overlay the site-specific minimum, annual average, and maximum concentrations over several program-level statistical metrics. For the program-level statistics, the first, second (median), third, and fourth (maximum) quartiles are shown as colored segments on a "bar" where the color changes correspond to the exact numerical value of the quartile. The thin vertical line represents the program-level average concentration. The site-specific annual average is shown as a black (2015) or white (2016) circle plotted on top of the bar and the horizontal lines extending outward from the circles represent the minimum and maximum concentration measured at the site. An example of this figure is shown in Figure 5-6. Note that the program-level average concentrations shown for VOCs, SNMOCs, and carbonyl compounds in Tables 4-1, 4-2, and 4-4 are presented in method-specific units, but have been converted to a common unit of measurement ($\mu g/m^3$) for the purposes of this data analysis. These graphs are presented in Sections 5 through 23, and are grouped by pollutant within each state section. This allows for both a "site vs. program" comparison as well as an inter-site comparison for sites within a given state.

3.4.2.2 Site Trends Analysis

Table 2-1 presents current monitoring sites that have participated in the NMP in previous years. A site-specific trends analysis was conducted for sites with at least 5 consecutive years of method-specific data analyzed under the NMP. The trends analysis was conducted for each of the site-specific pollutants of interest identified via the risk-based screening process. Forty-five

of the 53 monitoring sites have sampled at least one pollutant group long enough for the trends analysis to be conducted. The approach to this trends analysis is described below and the results are presented in the individual state sections (Sections 5 through 23).

Five individual 1-year statistical metrics were calculated for this data analysis and are presented as box and whisker plots, an example of which can be seen in Figure 5-17. The statistical metrics shown include the minimum and maximum concentration measured during each year of sampling (as shown by the upper and lower value of the lines extending from the box); the 5th percentile, 50th percentile (or median), and 95th percentile (as shown by the y-values corresponding with the bottom of the box, the thick blue line, and top of the box, respectively); and the average (or mean) concentration (as denoted by the orange diamond). Each of the statistical metrics incorporates all measurements collected during that 1-year period. For each 1-year period, there must be a minimum of 85 percent completeness, which corresponds to roughly 51 valid samples or approximately 10 months of sampling (for a site sampling on a 1-in-6 day sampling schedule) for an average concentration to be presented. For cases where sampling began mid-year or ended early, a minimum of 6 months of sampling is required. In these cases, a 1-year average is not provided but the concentration range and quartiles are still presented.

Historical data used in this analysis were downloaded from EPA's AQS database (EPA, 2017b) in order to ensure the use of the most up-to-date data available. Similar to other analyses presented in this report, zeros representing non-detects were incorporated into the statistical calculations.

In NMP reports prior to 2014, results from sample days with precision data (duplicates, collocates, and/or replicates) were averaged together to allow for the determination of a single concentration per pollutant and date for each site. For the 2014 NMP report, duplicate and replicate data were not downloaded from AQS due to a change in the availability of this data in AQS. However, for collocated results, the averaging schema was retained. This is also true for the 2015-2016 NMP report.

3.4.2.3 Cancer Risk and Noncancer Hazard Approximations

Risk was further examined by calculating cancer risk and noncancer hazard approximations for each of the site-specific pollutants of interest. The cancer risk approximations presented in this report estimate the cancer risk due to exposure to a given pollutant at the annual average concentration over a 70-year period (not the risk resulting from exposure over the time period covered in this report). A cancer risk approximation less than 1 in-a-million is considered negligible; a cancer risk greater than 1 in-a-million but less than 100 in-a-million is generally considered acceptable; and a cancer risk greater than 100 in-a-million is considered significant (EPA, 2009b). The noncancer hazard approximation is presented as the Noncancer Hazard Quotient (HQ), which is a unitless value. According to EPA, "A hazard quotient less than or equal to one indicates that adverse noncancer effects are not likely to occur, and thus can be considered to have negligible hazard." (EPA, 2015a).

The toxicity factors applied to calculate the cancer risk and noncancer hazard approximations are typically UREs (for cancer) or RfCs (for noncancer), which are developed by EPA. However, UREs and RfCs are not available for all pollutants. In the absence of EPA values, toxicity factors developed by agencies with credible methods and that are similar in scope and definition were used (EPA, 2015b). Cancer URE and noncancer RfC toxicity factors can be applied to the annual average concentrations to approximate risk based on ambient monitoring data. While the cancer risk and noncancer hazard approximations do not incorporate human activity patterns and therefore do not reflect true human inhalation exposure, they may allow analysts to further refine their focus by identifying concentrations of specific pollutants that may present health risks. Cancer UREs and/or noncancer RfCs, site-specific annual averages, and corresponding annual average-based cancer risk and noncancer hazard approximations are presented in each state section (Sections 5 through 23).

To further this data analysis, pollution roses were created for each of the site-specific pollutants of interest that have cancer risk approximations greater than 75 in-a-million and/or a noncancer hazard approximation greater than 1.0, where applicable. This data analysis is performed to help identify the geographical area where the emissions sources of these pollutants may have originated. A pollution rose is a plot of the ambient concentration versus the wind speed and direction; high concentrations may be shown in relation to the direction of potential emissions sources.

There are, however, limitations to this data analysis. Wind data are typically obtained from the National Centers for Environmental Information (NCEI), part of the National Oceanic and Atmospheric Administration (NOAA), for the nearest observation station (NOAA, 2017). These are hourly observations while concentrations from this report are 24-hour measurements. Thus, the wind data must be averaged for comparison to the concentrations data. Wind speed and direction can fluctuate throughout a given day or change dramatically if a frontal system moves through. Thus, the average calculated wind data may not be completely representative of a given day. This can be investigated more thoroughly if the need arises.

3.4.2.4 Risk-Based Emissions Assessment

A pollutant emitted in high quantities does not necessarily present a higher risk to human health than a pollutant emitted in very low quantities. The more toxic the pollutant, the more risk associated with its emissions in ambient air. The development of various health-based toxicity factors, as discussed in previous sections, has allowed analysts to apply weight to the emissions of pollutants based on toxicity rather than mass emissions. This approach considers both a pollutant's toxicity potential and the quantity emitted.

This assessment compares county-level emissions to toxicity-weighted emissions based on the EPA-approved approach described below (EPA, 2007). The 10 pollutants with the highest total mass emissions and the 10 pollutants with the highest associated toxicity-weighted emissions for pollutants with cancer and noncancer toxicity factors are presented in each state section. While the *absolute magnitude* of the pollutant-specific toxicity-weighted emissions is not meaningful, the *relative magnitude* of toxicity-weighted emissions is useful in identifying the order of potential priority for air quality managers. Higher values suggest greater priority; however, even the highest values may not reflect potential cancer effects greater than the level of concern (100 in-a-million) or potential noncancer effects above the level of concern (e.g., HQ greater than or equal to 1.0). The pollutants exhibiting the 10 highest annual average-based risk approximations for cancer and noncancer effects are also presented in each state section. The results of this data analysis may help state, local, and tribal agencies better understand which pollutants emitted, from a toxicity basis, are of the greatest concern and whether or not these pollutants are already being monitoring or perhaps should be monitored in the future.

The toxicity-weighted emissions approach consists of the following steps:

1. Obtain HAP emissions data for all anthropogenic sectors (nonpoint, point, onroad, and nonroad) from the NEI. For point sources, sum the process-level emissions to the county-level. Biogenic emissions are not included in this data analysis.

2. Apply the mass extraction speciation profiles to extract metal and cyanide mass.

3. Apply weight to the emissions derived from the steps above based on their toxicity. The results of the toxicity-weighting process are unitless.
    a. To apply weight based on cancer toxicity, multiply the emissions of each pollutant by its cancer URE.
    b. To apply weight based on noncancer toxicity, divide the emissions of each pollutant by its noncancer RfC.

The PAHs measured using Method TO-13A are a sub-group of Polycyclic Organic Matter (POM). Because these compounds are often not speciated into individual compounds in the NEI, the PAHs are grouped into POM Groups in order to assess risk attributable to these pollutants. Thus, emissions data and toxicity-weighted emissions for many of the PAHs are presented by POM Groups for this data analysis. Table 3-3 presents the 22 PAHs measured with Method TO-13A and their associated POM Groups, if applicable.

The POM groups are sub-grouped in Table 3-3 because toxicity research has led to the refining of UREs for certain PAHs. With the release of the 2011 NATA, the POM Groups have been renamed, although the grouping is still based on the same risk levels. For simplicity's sake, the original names are provided in the data analysis, but both names are provided in Table 3-3. Note the following in regard to Table 3-3:

- naphthalene emissions are reported to the NEI individually; therefore, it is not included in one of the POM Groups;

- four pollutants analyzed using Method TO-13A and listed in Table 3-3 do not have assigned POM Groups;

- anthracene, phenanthrene, and pyrene used to be part of POM Group 2 (2d) but have been removed.

Table 3-3. POM Groups for PAHs[1]

Pollutant	POM Group	POM Subgroup	New POM Grouping
Acenaphthene	Group 2	Group 2b	PAH_880E5
Acenaphthylene	Group 2	Group 2b	PAH_880E5
Anthracene	NA		PAH_000E0
Benzo(a)anthracene	Group 6		PAH_176E4
Benzo(a)pyrene	Group 5	Group5a	PAH_176E3
Benzo(b)fluoranthene	Group 6		PAH_176E4
Benzo(e)pyrene	Group 2	Group 2b	PAH_880E5
Benzo(g,h,i)perylene	Group 2	Group 2b	PAH_880E5
Benzo(k)fluoranthene	Group 6		PAH_176E4
Chrysene	Group 7		PAH_176E5
Coronene	NA		
Cyclopenta[cd]pyrene	NA		
Dibenz(a,h)anthracene	Group 5	Group5b	PAH_192E3
Fluoranthene	Group 2	Group 2b	PAH_880E5
Fluorene	Group 2	Group 2b	PAH_880E5
9-Fluorenone	NA		
Indeno(1,2,3-cd)pyrene	Group 6		PAH_176E4
Naphthalene*	NA		
Perylene	Group 2	Group 2b	PAH_880E5
Phenanthrene	NA		PAH_000E0
Pyrene	NA		PAH_000E0
Retene	NA		

[1] Reference: EPA, 2015c

* Emissions for naphthalene are reported to the NEI individually; therefore, naphthalene is not included in one of the POM Groups.

NA = POM Group not assigned.

4.0 Summary of the 2015-2016 National Monitoring Programs Data

This section summarizes the results of the data analyses performed on the NMP dataset, as described in Section 3.

4.1 Statistical Results

This section examines the following statistical parameters for the target pollutants of each analytical method: 1) detection rates, 2) concentration ranges and data distribution, and 3) central tendency statistics. Tables 4-1 through 4-6 present statistical summaries for the target pollutants and Sections 4.1.1 through 4.1.3 review the basic findings of these statistical calculations.

> The 2015-2016 NMP report includes data from samples collected at monitoring sites participating under the NMP with the support of the national contract laboratory.

4.1.1 Target Pollutant Detection Rates

There is an experimentally-determined MDL for every target pollutant, as described in Section 2.2. Quantification less than the MDL is possible, although the measurement's reliability is lower. If a concentration does not exceed the MDL, it does not mean that the pollutant is not present in the air. If the instrument does not generate a numerical concentration, the measurement is marked as "ND," or "non-detect." As explained in Section 2.2, data analysts should exercise caution when interpreting monitoring data with a high percentage of reported concentrations at levels near or less than the corresponding MDL. A thorough review of the number of measured detections, the number of non-detects, and the total number of samples is beneficial to understanding the representativeness of the interpretations made.

Tables 4-1 through 4-7 summarize the number of times each target pollutant was detected out of the number of valid samples collected and analyzed. Approximately 54 percent of the reported measurements (based on the preprocessed daily measurements) were equal to or greater than their respective MDLs across the program. The following list provides the percentage of measurements that were greater than the MDLs for each of the target pollutant groups:

- 40 percent for VOCs
- 52 percent for SNMOCs
- 100 percent for methane
- 83 percent for carbonyl compounds

- 61 percent for PAHs
- 85 percent for metals
- 69 percent for hexavalent chromium.

Some pollutants were detected in every valid sample collected while others were infrequently detected or not detected at all. Ten VOCs (benzene, carbon disulfide, carbon tetrachloride, chloromethane, dichlorodifluoromethane, dichloromethane, propylene, toluene, trichlorofluoromethane, and trichlorotrifluoroethane) were detected in every valid VOC sample collected (2,934), based on the preprocessed daily measurements across both years of sampling. Eight pollutants (acetylene, *n*-butane, ethane, ethylene, *n*-heptane, propane, propylene, and toluene) were detected in every valid SNMOC sample collected (854). Methane was detected in all 134 samples collected. Formaldehyde and acetone were detected in every valid carbonyl compound sample collected (3,157). Fluoranthene, naphthalene, phenanthrene, and pyrene were detected in every valid PAH sample collected (2,239). Antimony, cadmium, cobalt, lead, and manganese were detected in every valid speciated metals sample collected (2,146). Hexavalent chromium was detected in 59 of the 84 valid samples collected.

BTUT and NBIL have the greatest number of measured detections by a considerable margin (more than 13,000 for each). But they are the only two NMP sites that collected samples for at least five analytical methods/pollutant groups. They are also among the five sites to sample both VOCs and SNMOCs but are the only two to sample throughout both 2015 and 2016. However, the detection rates for BTUT and NBIL (67 percent and 65 percent, respectively) were not as high as other sites. The detection rate at a given site may result from multiple factors that must be considered when reviewing such a metric. Concentration levels are the primary factor, certainly, although which pollutant groups are sampled for also plays a role. For example, metals were rarely reported as non-detects. As a result, sites that sampled only metals (such as ASKY-M and PAFL) would be expected to have higher detection rates. The detection rate for each of these sites is nearly 100 percent. Conversely, VOCs had one of the lowest percentages of concentrations greater than the MDLs (40 percent). A site measuring only VOCs would be expected to have relatively low detection rates, such as ASKY or SPAZ (both approximately 53 percent).

Table 4-1. Statistical Summaries of the VOC Concentrations

Pollutant	# of Non-Detects[1]	# of Measured Detections[1]	# of Measured Detections <MDL	Minimum[2] (ppbv)	Maximum (ppbv)	Arithmetic Mean (ppbv)	Median (ppbv)	First Quartile (ppbv)	Third Quartile (ppbv)	Standard Deviation (ppbv)
Acetonitrile	2	2,932	35	0.026	1940	5.634	0.353	0.153	1.78	41.4
Acetylene	2	2,932	0	0.075	36.0	0.992	0.554	0.354	0.956	1.92
Acrolein	251	2,683	93	0.033	0.996	0.350	0.303	0.173	0.497	0.238
Acrylonitrile	2,824	99	3	0.012	0.48	0.003	0	0	0	0.021
tert-Amyl Methyl Ether	2,831	103	85	0.003	0.011	0.000	0	0	0	0.001
Benzene	0	2,934	0	0.034	2.29	0.225	0.182	0.130	0.264	0.169
Bromochloromethane[5]	2,795	139	54	0.001	0.033	0.001	0	0	0	0.004
Bromodichloromethane	2,532	401	299	0.004	3.62	0.012	0	0	0	0.151
Bromoform	2,682	252	238	0.004	0.087	0.001	0	0	0	0.004
Bromomethane	36	2,898	1,481	0.007	5.14	0.022	0.015	0.011	0.019	0.118
1,3-Butadiene	226	2,708	863	0.003	1.76	0.039	0.025	0.014	0.042	0.072
Carbon Disulfide	0	2,934	1,416	0.003	2.49	0.039	0.015	0.011	0.025	0.143
Carbon Tetrachloride	0	2,934	1	0.006	0.587	0.101	0.101	0.093	0.110	0.023
Chlorobenzene	2,435	499	475	0.003	0.044	0.002	0	0	0	0.004
Chloroethane[5]	906	2,028	578	0.001	0.247	0.021	0.020	0	0.030	0.021
Chloroform	53	2,881	34	0.012	11.6	0.055	0.026	0.021	0.035	0.352
Chloromethane[5]	0	2,934	0	0.321	3.95	0.603	0.601	0.543	0.659	0.118
Chloroprene	2,930	4	0	0.010	0.020	0.000	0	0	0	0.001
Dibromochloromethane	1,747	1,187	1,122	0.001	1.64	0.007	0	0	0.005	0.061
1,2-Dibromoethane	2,837	97	96	0.005	0.023	0.000	0	0	0	0.002
m-Dichlorobenzene	2,741	193	191	0.003	0.104	0.001	0	0	0	0.003
o-Dichlorobenzene	2,662	272	270	0.003	0.108	0.001	0	0	0	0.003
p-Dichlorobenzene	1,668	1,266	1,051	0.003	0.461	0.008	0	0	0.010	0.019
Dichlorodifluoromethane[5]	0	2,934	0	0.321	1.36	0.519	0.517	0.485	0.552	0.060
1,1-Dichloroethane	2,741	193	98	0.005	0.274	0.002	0	0	0	0.011

[1] Out of 2,934 valid samples

[2] Excludes zeros for non-detects.

[3] The total number of concentrations may not add up to 2,934 for some compounds where no value could be reported due to co-elution.

[4] The total number of concentrations may not add up to 2,934 for compounds affected by internal standard contamination in 2015.

[5] Concentrations for this pollutant were blank-subtracted due to internal standard contamination in 2016.

Table 4-1. Statistical Summaries of the VOC Concentrations (Continued)

Pollutant	# of Non-Detects[1]	# of Measured Detections[1]	# of Measured Detections <MDL	Minimum[2] (ppbv)	Maximum (ppbv)	Arithmetic Mean (ppbv)	Median (ppbv)	First Quartile (ppbv)	Third Quartile (ppbv)	Standard Deviation (ppbv)
1,2-Dichloroethane	193	2,741	217	0.007	11.3	0.074	0.020	0.016	0.025	0.415
1,1-Dichloroethene	2,472	462	415	0.003	0.139	0.001	0	0	0	0.004
cis-1,2-Dichloroethylene	2,932	2	0	0.033	0.071	0.000	0	0	0	0.001
trans-1,2-Dichloroethylene	2,601	333	154	0.003	6.58	0.012	0	0	0	0.166
Dichloromethane	0	2,934	0	0.042	429	0.975	0.119	0.092	0.198	12.1
1,2-Dichloropropane	2,769	165	152	0.006	0.097	0.001	0	0	0	0.004
cis-1,3-Dichloropropene	2,917	17	13	0.004	0.037	0.000	0	0	0	0.001
trans-1,3-Dichloropropene	2,931	3	1	0.008	0.029	0.000	0	0	0	0.001
Dichlorotetrafluoroethane[5]	2	2,932	1,423	0.001	0.526	0.018	0.017	0.015	0.020	0.011
Ethyl Acrylate	2,896	38	29	0.004	0.022	0.000	0	0	0	0.001
Ethyl *tert*-Butyl Ether	2,469	465	184	0.003	0.103	0.003	0	0	0	0.010
Ethylbenzene	7	2,927	486	0.003	0.706	0.059	0.040	0.023	0.073	0.058
Hexachloro-1,3-butadiene[4]	1,410	343	342	0.002	0.095	0.002	0	0	0	0.004
Methyl Isobutyl Ketone	241	2,688	431	0.006	1.20	0.040	0.031	0.019	0.049	0.044
Methyl Methacrylate	2,568	366	310	0.003	0.314	0.002	0	0	0	0.011
Methyl *tert*-Butyl Ether	2,664	270	77	0.003	0.174	0.002	0	0	0	0.008
n-Octane	121	2,813	518	0.006	2.03	0.058	0.033	0.018	0.063	0.096
Propylene[5]	0	2,934	12	0.026	40.0	0.538	0.306	0.204	0.502	1.35
Styrene	755	2,179	891	0.004	22.2	0.138	0.015	0	0.029	0.839
1,1,2,2-Tetrachloroethane	2,600	334	333	0.003	0.051	0.001	0	0	0	0.003
Tetrachloroethylene	636	2,298	1,094	0.004	2.00	0.021	0.012	0.006	0.021	0.053
Toluene	0	2,934	0	0.025	34.6	0.502	0.280	0.145	0.549	1.14
1,2,4-Trichlorobenzene[4]	1,724	29	28	0.004	0.207	0.000	0	0	0	0.005
1,1,1-Trichloroethane	869	2,065	2,009	0.002	0.098	0.005	0.005	0	0.008	0.005
1,1,2-Trichloroethane	2,846	88	54	0.006	0.378	0.001	0	0	0	0.013

[1] Out of 2,934 valid samples

[2] Excludes zeros for non-detects.

[3] The total number of concentrations may not add up to 2,934 for some compounds where no value could be reported due to co-elution.

[4] The total number of concentrations may not add up to 2,934 for compounds affected by internal standard contamination in 2015.

[5] Concentrations for this pollutant were blank-subtracted due to internal standard contamination in 2016.

Table 4-1. Statistical Summaries of the VOC Concentrations (Continued)

Pollutant	# of Non-Detects[1]	# of Measured Detections[1]	# of Measured Detections <MDL	Minimum[2] (ppbv)	Maximum (ppbv)	Arithmetic Mean (ppbv)	Median (ppbv)	First Quartile (ppbv)	Third Quartile (ppbv)	Standard Deviation (ppbv)
Trichloroethylene	2,307	627	396	0.004	1.08	0.006	0	0	0	0.032
Trichlorofluoromethane[5]	0	2,934	0	0.127	1.54	0.255	0.246	0.227	0.268	0.076
Trichlorotrifluoroethane	0	2,934	0	0.051	0.124	0.081	0.081	0.076	0.087	0.009
1,2,4-Trimethylbenzene	67	2,867	774	0.003	0.801	0.057	0.036	0.020	0.069	0.063
1,3,5-Trimethylbenzene	447	2,487	1,661	0.003	0.274	0.018	0.013	0.007	0.024	0.020
Vinyl chloride[5]	2,020	914	609	0.001	5.11	0.021	0	0	0.006	0.156
m,p-Xylene	4	2,930	357	0.005	2.39	0.155	0.100	0.052	0.195	0.173
o-Xylene	17	2,917	411	0.003	0.733	0.066	0.044	0.024	0.083	0.068

[1] Out of 2,934 valid samples

[2] Excludes zeros for non-detects.

[3] The total number of concentrations may not add up to 2,934 for some compounds where no value could be reported due to co-elution.

[4] The total number of concentrations may not add up to 2,934 for compounds affected by internal standard contamination in 2015.

[5] Concentrations for this pollutant were blank-subtracted due to internal standard contamination in 2016.

Table 4-2. Statistical Summaries of the SNMOC Concentrations

Pollutant	# of Non-Detects[1]	# of Measured Detections[1]	# of Measured Detections <MDL	Minimum[2] (ppbC)	Maximum (ppbC)	Arithmetic Mean (ppbC)	Median (ppbC)	First Quartile (ppbC)	Third Quartile (ppbC)	Standard Deviation (ppbC)
Acetylene	0	854	0	0.109	8.79	1.32	0.971	0.606	1.61	1.12
Benzene[3]	0	843	0	0.244	12.4	1.58	1.34	0.921	1.96	1.03
1,3-Butadiene[3]	643	209	57	0.037	0.561	0.047	0	0	0	0.098
n-Butane	0	854	0	0.710	280	16.6	7.61	4.58	15.9	27.2
1-Butene[3]	4	7	2	0.045	0.598	0.110	0.058	0	0.127	0.164
cis-2-Butene	408	446	1	0.040	1.10	0.104	0.058	0	0.157	0.151
trans-2-Butene	515	339	0	0.046	1.67	0.134	0	0	0.213	0.225
Cyclohexane	11	843	3	0.086	28.3	1.90	1.40	0.547	2.42	2.12
Cyclopentane[3]	102	689	0	0.063	24.1	0.559	0.374	0.261	0.617	1.01
Cyclopentene[3]	765	78	18	0.047	1.13	0.023	0	0	0	0.102
n-Decane	87	767	311	0.085	65.8	0.650	0.360	0.198	0.574	2.56
1-Decene	850	4	2	0.109	2.34	0.004	0	0	0	0.082
m-Diethylbenzene	840	14	4	0.195	2.84	0.012	0	0	0	0.128
p-Diethylbenzene	835	19	4	0.110	8.83	0.028	0	0	0	0.354
2,2-Dimethylbutane[3]	99	742	31	0.055	47.2	0.395	0.284	0.163	0.446	1.64
2,3-Dimethylbutane	12	842	7	0.047	102	0.717	0.465	0.269	0.767	3.51
2,3-Dimethylpentane	15	839	4	0.064	4.06	0.589	0.431	0.286	0.731	0.469
2,4-Dimethylpentane	48	806	39	0.060	2.60	0.355	0.288	0.173	0.455	0.284
n-Dodecane	294	560	369	0.069	78.3	0.393	0.159	0	0.291	2.86
1-Dodecene	835	19	12	0.204	8.11	0.034	0	0	0	0.389
Ethane	0	854	0	3.04	482	44.8	27.4	11.4	51.6	55.5
2-Ethyl-1-butene	853	1	0	2.29		Single Measured Detection				
Ethylbenzene	82	772	52	0.072	2.64	0.380	0.290	0.166	0.482	0.352
Ethylene	0	854	0	0.415	10.4	2.26	1.75	1.26	2.69	1.58
m-Ethyltoluene	207	647	27	0.098	4.36	0.434	0.348	0.129	0.632	0.427
o-Ethyltoluene	521	333	78	0.075	13.2	0.151	0	0	0.217	0.507

[1] Out of 854 valid samples.
[2] Excludes zeros for non-detects.
[3] The total number of concentrations may not add up to 854 for some compounds where no value could be reported due to co-elution.
NA = Not applicable for these parameters.

Table 4-2. Statistical Summaries of the SNMOC Concentrations (Continued)

Pollutant	# of Non-Detects[1]	# of Measured Detections[1]	# of Measured Detections <MDL	Minimum[2] (ppbC)	Maximum (ppbC)	Arithmetic Mean (ppbC)	Median (ppbC)	First Quartile (ppbC)	Third Quartile (ppbC)	Standard Deviation (ppbC)
p-Ethyltoluene	302	552	57	0.068	3.04	0.225	0.185	0	0.327	0.274
n-Heptane	0	854	1	0.106	18.8	1.90	1.26	0.616	2.30	2.15
1-Heptene[3]	809	44	1	0.084	1.24	0.021	0	0	0	0.104
n-Hexane	1	853	0	0.176	45.2	4.21	2.59	1.38	4.328	5.55
1-Hexene	317	537	48	0.042	1.13	0.102	0.084	0	0.156	0.117
cis-2-Hexene	826	28	13	0.044	0.283	0.003	0	0	0	0.020
trans-2-Hexene	761	93	10	0.056	0.262	0.011	0	0	0	0.035
Isobutane	1	853	0	0.238	119	9.34	5.90	2.62	10.4	11.5
Isobutylene[3]	4	8	2	0.099	0.484	0.138	0.109	0	0.188	0.140
Isopentane[3]	12	150	0	0.544	93.6	14.1	6.27	2.58	16.5	18.6
Isoprene[3]	249	604	42	0.045	10.8	0.713	0.134	0	0.857	1.26
Isopropylbenzene	755	99	27	0.065	3.73	0.027	0	0	0	0.157
2-Methyl-1-butene[3]	438	348	1	0.089	1.31	0.150	0	0	0.293	0.196
3-Methyl-1-butene[3]	848	0	0	Not Detected						
2-Methyl-1-pentene	816	38	22	0.045	0.163	0.004	0	0	0	0.018
4-Methyl-1-pentene	844	10	1	0.049	0.717	0.003	0	0	0	0.032
2-Methyl-2-butene[3]	353	433	0	0.095	1.50	0.201	0.185	0	0.337	0.230
Methylcyclohexane[3]	48	725	0	0.114	37.5	3.16	2.31	0.979	4.55	3.13
Methylcyclopentane[3]	7	840	0	0.129	19.5	2.01	1.51	0.819	2.45	1.92
2-Methylheptane[3]	138	715	70	0.067	4.05	0.538	0.397	0.167	0.722	0.561
3-Methylheptane[3]	74	779	22	0.064	2.84	0.422	0.328	0.172	0.570	0.377
2-Methylhexane[3]	10	842	3	0.168	10.4	1.83	1.57	1.03	2.32	1.23
3-Methylhexane[3]	195	294	4	0.206	9.84	1.24	0.928	0	1.68	1.64
2-Methylpentane[3]	5	825	0	0.317	483	4.10	2.63	1.64	4.19	17.0
3-Methylpentane	2	852	0	0.114	184	1.91	1.20	0.676	1.99	6.48
n-Nonane	33	821	151	0.078	50.9	0.586	0.371	0.212	0.637	1.84

[1] Out of 854 valid samples.
[2] Excludes zeros for non-detects.
[3] The total number of concentrations may not add up to 854 for some compounds where no value could be reported due to co-elution.
NA = Not applicable for these parameters.

Table 4-2. Statistical Summaries of the SNMOC Concentrations (Continued)

Pollutant	# of Non-Detects[1]	# of Measured Detections[1]	# of Measured Detections <MDL	Minimum[2] (ppbC)	Maximum (ppbC)	Arithmetic Mean (ppbC)	Median (ppbC)	First Quartile (ppbC)	Third Quartile (ppbC)	Standard Deviation (ppbC)
1-Nonene	248	606	121	0.065	8.54	0.160	0.135	0	0.216	0.321
n-Octane	2	852	58	0.084	8.35	1.16	0.825	0.445	1.54	1.06
1-Octene	228	626	74	0.076	2.14	0.249	0.228	0	0.368	0.237
n-Pentane[3]	0	853	0	0.478	118	8.55	4.38	2.61	8.51	12.5
1-Pentene[3]	96	757	5	0.066	6.44	0.260	0.202	0.134	0.307	0.366
cis-2-Pentene[3]	546	307	44	0.047	0.451	0.041	0	0	0.075	0.065
trans-2-Pentene[3]	218	635	21	0.041	1.04	0.142	0.115	0	0.206	0.139
a-Pinene[3]	490	363	40	0.072	12.9	0.335	0	0	0.372	0.800
b-Pinene[3]	844	5	0	1.21	8.30	0.019	0	0	0	0.323
Propane	0	854	0	1.05	476	32.6	17.1	8.52	31.7	49.2
n-Propylbenzene	557	297	26	0.049	2.02	0.090	0	0	0.157	0.165
Propylene	0	854	0	0.169	5.56	0.963	0.784	0.523	1.20	0.635
Propyne	832	22	0	0.062	0.258	0.003	0	0	0	0.022
Styrene[3]	590	112	35	0.108	21.8	0.626	0	0	0	2.24
Toluene	0	854	0	0.573	255	5.93	3.53	2.28	5.66	14.9
n-Tridecane	658	196	154	0.086	46.4	0.248	0	0	0	2.14
1-Tridecene	854	0	0	Not Detected						
1,2,3-Trimethylbenzene	399	455	240	0.078	6.65	0.163	0.100	0	0.213	0.326
1,2,4-Trimethylbenzene	14	840	186	0.088	19.6	0.805	0.603	0.395	0.979	0.898
1,3,5-Trimethylbenzene	315	539	105	0.074	3.37	0.209	0.172	0	0.333	0.246
2,2,3-Trimethylpentane	779	75	1	0.046	0.812	0.025	0	0	0	0.095
2,2,4-Trimethylpentane[3]	302	488	1	0.072	79.3	0.685	0.306	0	0.768	2.93
2,3,4-Trimethylpentane[3]	167	685	61	0.057	3.62	0.293	0.212	0.096	0.364	0.342
n-Undecane	203	651	474	0.066	16.8	0.271	0.171	0.087	0.292	0.691
1-Undecene	779	75	66	0.070	2.65	0.024	0	0	0	0.139
m-Xylene/*p*-Xylene	3	851	4	0.120	9.03	1.45	1.18	0.677	1.90	1.07

[1] Out of 854 valid samples.
[2] Excludes zeros for non-detects.
[3] The total number of concentrations may not add up to 854 for some compounds where no value could be reported due to co-elution.
NA = Not applicable for these parameters.

Table 4-2. Statistical Summaries of the SNMOC Concentrations (Continued)

Pollutant	# of Non-Detects[1]	# of Measured Detections[1]	# of Measured Detections <MDL	Minimum[2] (ppbC)	Maximum (ppbC)	Arithmetic Mean (ppbC)	Median (ppbC)	First Quartile (ppbC)	Third Quartile (ppbC)	Standard Deviation (ppbC)
o-Xylene	12	842	6	0.071	7.35	0.555	0.431	0.281	0.662	12
SNMOC (Sum of Knowns)	NA	NA	NA	15.5	1,720	163	107	63.2	178	15.5
Sum of Unknowns	NA	NA	NA	15.2	1,860	117	87.8	58.2	138	15.2
TNMOC	NA	NA	NA	44.7	1,970	281	214	141	338	44.7

[1] Out of 854 valid samples.
[2] Excludes zeros for non-detects.
[3] The total number of concentrations may not add up to 854 for some compounds where no value could be reported due to co-elution.
NA = Not applicable for these parameters.

Table 4-3. Statistical Summaries of the Methane Concentrations[1]

Pollutant	# of Non-Detects	# of Measured Detections[2]	# of Measured Detections <MDL	Minimum (ppmC)	Maximum (ppmC)	Arithmetic Mean (ppmC)	Median (ppmC)	First Quartile (ppmC)	Third Quartile (ppmC)	Standard Deviation (ppmC)
Methane	0	134	0	1.94	4.01	2.51	2.41	2.22	2.74	0.409

[1] Includes samples collected at two sites (NROK and BROK).
[2] Out of 134 valid samples.

Table 4-4. Statistical Summaries of the Carbonyl Compound Concentrations

Pollutant	# of Non-Detects[1]	# of Measured Detections[1]	# of Measured Detections <MDL	Minimum[2] (ppbv)	Maximum (ppbv)	Arithmetic Mean (ppbv)	Median (ppbv)	First Quartile (ppbv)	Third Quartile (ppbv)	Standard Deviation (ppbv)
Acetaldehyde[3]	0	3,155	0	0.016	9.52	0.923	0.790	0.533	1.17	0.654
Acetone	0	3,157	4	0.027	19.0	1.19	0.945	0.559	1.50	1.14
Benzaldehyde[3]	18	3,030	0	0.003	1.34	0.034	0.026	0.017	0.038	0.049
2-Butanone[3]	6	3,126	0	0.005	5.15	0.245	0.170	0.110	0.279	0.321
Butyraldehyde[3]	18	3,133	4	0.003	2.98	0.104	0.080	0.053	0.120	0.122
Crotonaldehyde[3]	30	3,098	2	0.004	2.09	0.125	0.053	0.026	0.146	0.179
2,5-Dimethylbenzaldehyde	3,157	0	0	Not Detected						
Formaldehyde	0	3,157	0	0.017	20.7	2.47	2.01	1.25	3.07	2.04
Hexaldehyde[3]	65	3,083	13	0.002	1.16	0.039	0.024	0.014	0.038	0.069
Isovaleraldehyde	3,157	0	0	Not Detected						
Propionaldehyde[3]	30	3,098	0	0.004	2.45	0.133	0.112	0.073	0.171	0.108
Tolualdehydes[3]	88	2,879	51	0.002	0.453	0.029	0.023	0.015	0.034	0.026
Valeraldehyde[3]	94	3,037	4	0.002	1.14	0.033	0.024	0.015	0.037	0.046

[1] Out of 3,157 valid samples.

[2] Excludes zeros for non-detects.

[3] The total number of concentrations may not add up to 3,157 for some compounds where no value could be reported due to co-elution.

Table 4-5. Statistical Summaries of the PAH Concentrations

Pollutant	# of Non-Detects[1]	# of Measured Detections[1]	# of Measured Detections <MDL	Minimum[2] (ng/m^3)	Maximum (ng/m^3)	Arithmetic Mean (ng/m^3)	Median (ng/m^3)	First Quartile (ng/m^3)	Third Quartile (ng/m^3)	Standard Deviation (ng/m^3)
Acenaphthene	410	1,829	5	0.0979	108	4.36	1.66	0.679	3.74	9.01
Acenaphthylene	987	1,252	18	0.020	18.1	0.391	0.108	0	0.359	1.01
Anthracene	274	1,965	415	0.0118	29.3	0.375	0.159	0.064	0.360	1.20
Benzo(a)anthracene	185	2,054	1,232	0.00321	6.46	0.093	0.049	0.023	0.099	0.204
Benzo(a)pyrene	451	1,788	1,117	0.00198	5.82	0.095	0.045	0.012	0.109	0.197
Benzo(b)fluoranthene	123	2,116	792	0.00553	5.74	0.179	0.106	0.046	0.212	0.250
Benzo(e)pyrene	104	2,135	942	0.00392	3.87	0.124	0.073	0.034	0.149	0.171
Benzo(g,h,i)perylene	45	2,194	786	0.00348	3.63	0.137	0.076	0.038	0.159	0.205
Benzo(k)fluoranthene	1,209	1,030	656	0.00515	3.23	0.041	0	0	0.050	0.105
Chrysene[3]	9	2,229	537	0.0068	6.39	0.217	0.143	0.078	0.267	0.268
Coronene	135	2,104	847	0.00305	2.47	0.069	0.038	0.019	0.076	0.121
Cyclopenta(c,d)pyrene	1,205	1,034	390	0.00172	2.70	0.037	0	0	0.033	0.126
Dibenz(a,h)anthracene	872	1,367	1,007	0.00272	0.776	0.016	0.009	0	0.021	0.029
Fluoranthene	0	2,239	38	0.0357	57.3	2.39	1.09	0.621	2.22	4.49
Fluorene	647	1,592	5	0.185	105	4.36	2.25	0	4.27	8.34
9-Fluorenone[3]	11	2,226	18	0.034	17.5	1.44	1.07	0.635	1.74	1.37
Indeno(1,2,3-c,d)pyrene	130	2,109	943	0.00495	3.43	0.111	0.064	0.028	0.131	0.155
Naphthalene	0	2,239	1	0.446	403	61.2	48.9	28.3	82.2	47.2
Perylene	1,245	994	502	0.00171	1.23	0.015	0	0	0.018	0.039
Phenanthrene	0	2,239	6	0.190	272	10.7	5.24	2.73	9.94	20.3
Pyrene	0	2,239	89	0.0156	23.9	1.20	0.673	0.394	1.22	1.89
Retene	14	2,225	606	0.010	6.09	0.270	0.142	0.085	0.255	0.438

[1] Out of 2,239 valid samples.

[2] Excludes zeros for non-detects.

[3] The total number of concentrations may not add up to 2,239 for some compounds where no value could be reported due to co-elution.

Table 4-6. Statistical Summaries of the Metals Concentrations

Pollutant	# of Non-Detects[1]	# of Measured Detections[1]	# of Measured Detections <MDL	Minimum[2] (ng/m^3)	Maximum (ng/m^3)	Arithmetic Mean (ng/m^3)	Median (ng/m^3)	First Quartile (ng/m^3)	Third Quartile (ng/m^3)	Standard Deviation (ng/m^3)
PM_{10} Metals										
Antimony	0	1,544	6	0.0007	21.5	1.49	0.969	0.584	1.663	1.75
Arsenic	5	1,539	13	0.001	7.36	0.703	0.550	0.330	0.868	0.632
Beryllium	100	1,444	162	0.000002	0.442	0.011	0.006	0.003	0.014	0.017
Cadmium	0	1,544	7	0.0001	5.99	0.121	0.072	0.044	0.122	0.257
Chromium	1	1,543	1,286	0.045	33.4	3.51	2.98	2.12	4.27	2.34
Cobalt	0	1,544	422	0.000008	3.05	0.142	0.090	0.048	0.169	0.190
Lead	0	1,544	5	0.002	107	3.07	1.91	1.18	3.38	4.43
Manganese	0	1,544	5	0.005	202	8.51	5.55	3.06	10.3	10.5
Mercury	33	1,511	1,095	0.0001	0.157	0.014	0.011	0.008	0.017	0.013
Nickel	2	1,542	135	0.0009	69.5	1.09	0.737	0.408	1.30	2.16
Selenium	11	1,533	77	0.003	4.27	0.518	0.413	0.250	0.664	0.419
TSP Metals										
Antimony	0	602	0	0.100	12.4	0.772	0.604	0.408	0.872	0.834
Arsenic	0	602	0	0.088	5.65	0.695	0.611	0.439	0.826	0.448
Beryllium	0	602	1	0.001	0.130	0.018	0.013	0.008	0.020	0.017
Cadmium	0	602	0	0.023	3.79	0.180	0.131	0.090	0.203	0.225
Chromium	0	602	61	1.32	31.9	4.01	2.93	2.12	5.88	2.70
Cobalt	0	602	13	0.037	8.11	0.379	0.240	0.144	0.414	0.525
Lead	0	602	0	0.392	30.7	3.28	2.53	1.69	3.90	3.06
Manganese	0	602	0	1.91	92.5	17.8	14.7	9.24	22.2	12.8
Mercury	0	602	8	0.003	0.110	0.016	0.014	0.011	0.019	0.010
Nickel	0	602	38	0.305	22.1	1.25	0.986	0.654	1.49	1.23
Selenium	0	602	0	0.078	3.15	0.715	0.632	0.417	0.942	0.424

[1] For PM_{10}, out of 1,544 valid samples; for TSP, out of 602 valid samples.
[2] Excludes zeros for non-detects.

Table 4-7. Statistical Summary of the Hexavalent Chromium Concentrations[1]

Pollutant	# of Non-Detects[2]	# of Measured Detections[2]	# of Measured Detections <MDL	Minimum[3] (ng/m^3)	Maximum (ng/m^3)	Arithmetic Mean (ng/m^3)	Median (ng/m^3)	First Quartile (ng/m^3)	Third Quartile (ng/m^3)	Standard Deviation (ng/m^3)
Hexavalent Chromium	25	59	1	0.0025	0.116	0.0112	0.0097	0	0.0136	0.0161

[1] Includes samples collected at a single site (RIVA)
[2] Out of 86 valid samples. The total number of concentrations shown does not add up to 86 due to two samples where no value could be reported due to co-elution.
[3] Excludes zeros for non-detects.

4.1.2 Concentration Range and Data Distribution

The concentrations measured during the 2015-2016 NMP exhibit a wide range of variability. The minimum and maximum concentrations measured (excluding zeros substituted for non-detects) for each target pollutant are presented in Tables 4-1 through 4-7 (in respective pollutant group units). Some pollutants, such as dichloromethane, were measured across a wide range of concentrations, while other pollutants, such as dichlorotetrafluoroethane, were not, even though they were both detected frequently. For each method-specific pollutant group, the pollutant with the largest range in concentrations measured is as follows:

- For VOCs, acetonitrile (0.026 ppbv to 1,940 ppbv)
- For SNMOCs, 2-methylpentane (0.317 ppbC to 483 ppbC)
- For methane, concentrations ranged from 1.94 ppmC to 4.01 ppmC
- For carbonyl compounds, formaldehyde (0.017 ppbv to 20.7 ppbv)
- For PAHs, naphthalene (0.446 ng/m^3 to 403 ng/m^3)
- For metals in PM_{10}, manganese (0.005 ng/m^3 to 202 ng/m^3)
- For metals in TSP, manganese (1.91 ng/m^3 to 92.5 ng/m^3)
- For hexavalent chromium, concentrations ranged from 0.0025 ng/m^3 to 0.116 ng/m^3.

4.1.3 Central Tendency

In addition to the number of measured detections and the concentration ranges, Tables 4-1 through 4-7 also present several central tendency and data distribution statistics (arithmetic mean or average, median, first and third quartiles, and standard deviation) for each of the pollutants measured during the 2015-2016 NMP, in respective pollutant group units. A multitude of observations can be made from these tables. The pollutants with the three highest average concentrations for each method-specific pollutant group are provided below, with respective confidence intervals (the 95 percent confidence intervals are not provided in the tables).

The three VOCs with the highest average concentrations, as presented in Table 4-1, are:

- Acetonitrile (5.63 ± 1.50 ppbv)
- Acetylene (0.992 ± 0.069 ppbv)
- Dichloromethane (0.975 ± 0.436 ppbv).

The three SNMOCs with the highest average concentrations, as presented in Table 4-2, are:

- Ethane (44.8 ± 3.73 ppbC)
- Propane (32.6 ± 3.31 ppbC)
- *n*-Butane (16.6 ± 1.83 ppbC).

The average concentration of methane, as presented in Table 4-3, is 2.52 ± 0.07 ppmC.

The three carbonyl compounds with the highest average concentrations, as presented in Table 4-4, are:

- Formaldehyde (2.47 ± 0.07 ppbv)
- Acetone (1.19 ± 0.04 ppbv).
- Acetaldehyde (0.923 ± 0.023 ppbv).

The three PAHs with the highest average concentrations, as presented in Tables 4-5, are:

- Naphthalene (61.2 ± 1.96 ng/m^3)
- Phenanthrene (10.7 ± 0.84 ng/m^3)
- Acenaphthene (4.36 ± 0.73 ng/m^3).

The three metals with the highest average concentrations for both PM_{10} and TSP fractions, as presented in Table 4-6, are;

- Manganese (PM_{10} = 8.51 ± 0.51 ng/m^3, TSP = 17.8 ± 1.78 ng/m^3)
- Total chromium (PM_{10} = 3.51 ± 0.21 ng/m^3, TSP = 4.01 ± 0.47 ng/m^3)
- Lead (PM_{10} = 3.07 ± 0.17 ng/m^3, TSP = 3.28 ± 0.31 ng/m^3).

The average concentration of hexavalent chromium, as presented in Table 4-7, is 0.011 ± 0.004 ng/m^3.

Appendices J through P present statistical calculations on a site-specific basis, like those presented in Tables 4-1 through 4-7.

4.2 Preliminary Risk-Based Screening and Pollutants of Interest

Based on the preliminary risk-based screening process described in Section 3.2, Table 4-8 identifies the pollutants that failed at least one screen; summarizes each pollutant's total failed screens, total number of measured detections, percentage of screens failed, and cumulative percentage of failed screens; and highlights those pollutants contributing to the top 95 percent of failed screens (shaded in gray) and thereby designated as program-wide pollutants of interest. The results in this table are provided over both years of sampling. The number of failed screens, the number of measured detections, and the failure rate must all be considered when reviewing the results of the preliminary risk-based screening process.

The results in Table 4-8 are listed in descending order by number of screens failed. Table 4-8 shows that benzene failed the greatest number of screens (3,403). Carbon tetrachloride, formaldehyde, acetaldehyde, and 1,2-dichloroethane each failed greater than 2,700 screens. Each of these pollutants were among those with the greatest number of measured detections, among pollutants shown in Table 4-8, each with a detection rate greater than 95 percent. Seven pollutants listed in Table 4-8 failed only one screen each (1,2-dichloropropane, antimony, benzo(a)anthracene, benzo(b)fluoranthene, beryllium, dibenz(a,h)anthracene, and hexavalent chromium). The number of measured detections for these pollutants varied significantly. Several of these pollutants were detected in greater than 2,000 samples each, while 1,2-dichloropropane was detected in fewer than 6 percent of sample collected. Two pollutants exhibited a failure rate of 100 percent (1,2-dibromoethane and chloroprene). These pollutants were infrequently detected (1,2-dibromoethane and chloroprene were detected in 3 percent and less than 1 percent of samples collected, respectively).

Table 4-8. Results of the Program-Level Preliminary Risk-Based Screening Process

Pollutant	Screening Value ($\mu g/m^3$)	# of Failed Screens	# of Measured Detections	% of Failed Screens	% of Total Failures	Cumulative % Contribution
Benzene	0.13	3,403	3,406	99.91	14.29	14.29
Formaldehyde	0.077	3,150	3,157	99.78	13.23	27.52
Acetaldehyde	0.45	3,005	3,155	95.25	12.62	40.13
Carbon Tetrachloride	0.17	2,927	2,934	99.76	12.29	52.42
1,2-Dichloroethane	0.038	2,720	2,741	99.23	11.42	63.84
1,3-Butadiene	0.03	2,385	2,812	84.82	10.01	73.86
Arsenic	0.00023	1,910	2,141	89.21	8.02	81.88
Naphthalene	0.029	1,653	2,239	73.83	6.94	88.82
Ethylbenzene	0.4	525	3,338	15.73	2.20	91.02
p-Dichlorobenzene	0.091	388	1,266	30.65	1.63	92.65
Hexachloro-1,3-butadiene	0.045	298	343	86.88	1.25	93.90
Fluorene	0.011	199	1,592	12.50	0.84	94.74
Acenaphthene	0.011	197	1,829	10.77	0.83	95.57
Nickel	0.0021	183	2,144	8.54	0.77	96.33
Vinyl chloride	0.11	161	914	17.61	0.68	97.01
Manganese	0.03	127	2,146	5.92	0.53	97.54
1,2-Dibromoethane	0.0017	97	97	100.00	0.41	97.95
Fluoranthene	0.011	87	2,239	3.89	0.37	98.32
Propionaldehyde	0.8	87	3,098	2.81	0.37	98.68
Trichloroethylene	0.2	62	627	9.89	0.26	98.94
1,1,2-Trichloroethane	0.0625	51	88	57.95	0.21	99.16
Cadmium	0.00056	46	2,146	2.14	0.19	99.35
Benzo(a)pyrene	0.00057	44	1,788	2.46	0.18	99.53
Lead	0.015	29	2,146	1.35	0.12	99.66
Bromomethane	0.5	28	2,898	0.97	0.12	99.77
Dichloromethane	60	23	2,934	0.78	0.10	99.87
Chloroform	9.8	8	2,881	0.28	0.03	99.90
Acenaphthylene	0.011	4	1,252	0.32	0.02	99.92
Chloroprene	0.0021	4	4	100.00	0.02	99.94
1,1-Dichloroethane	0.625	3	193	1.55	0.01	99.95
Tetrachloroethylene	3.8	3	2,298	0.13	0.01	99.96
Xylenes	10	2	3,406	0.06	0.01	99.97
1,2-Dichloropropane	0.4	1	165	0.61	0.00	99.97
Antimony	0.02	1	2,146	0.05	0.00	99.98
Benzo(a)anthracene	0.0057	1	2,054	0.05	0.00	99.98
Benzo(b)fluoranthene	0.0057	1	2,116	0.05	0.00	99.99
Beryllium	0.00042	1	2,046	0.05	0.00	99.99
Dibenz(a,h)anthracene	0.00052	1	1,367	0.07	0.00	100.00
Hexavalent Chromium	0.000083	1	59	1.69	0.00	100.00
Total		23,816	74,205	32.09		

The program-level pollutants of interest, as indicated by the shading in Table 4-8, are identified as follows:

- Acenaphthene
- Acetaldehyde
- Arsenic
- Benzene
- 1,3-Butadiene
- Carbon Tetrachloride
- *p*-Dichlorobenzene
- 1,2-Dichloroethane
- Ethylbenzene
- Fluorene
- Formaldehyde
- Hexachloro-1,3-butadiene
- Naphthalene.

The pollutants of interest identified via the preliminary risk-based screening process for 2015 and 2016 are similar to the pollutants identified in previous years. Nickel is the only pollutant that was a program-wide pollutant of interest for in the 2014 NMP report but is not on the list for the 2015-2016 report. Nickel is the first pollutant just outside the 95 percent criteria, as shown in Table 4-8, and therefore is not a pollutant of interest for 2015-2016. Acenaphthene and fluorene were not on the list for 2014 but are for 2015-2016. Both of these have been identified as pollutants of interest in previous reports.

Of the pollutants that have corresponding screening values, concentrations of 39 pollutants failed at least one screen. Of these, a total of 23,816 concentrations out of 74,205 concentrations (or 32 percent) failed screens. If all pollutants with screening values are considered (including those that did not fail any screens), the percentage of concentrations failing screens is less (23,816 of 111,639, or 21 percent). Note that these percentages exclude acrolein, acetonitrile, acrylonitrile, and carbon disulfide measurements per the explanations provided in Section 3.2; these pollutants are excluded from all risk-related analyses contained in the report from this point forward.

Table 4-9 presents the total number of failed screens per site, in descending order, as a means of comparing the results of the preliminary risk-based screening process across the sites. In addition to the number of failed screens, Table 4-9 also provides the total number of screens conducted (one screen per valid preprocessed daily measurement for each site for all pollutants with screening values). The failure rate, as a percentage, was determined from the number of

failed screens and the total number of screens conducted (based on applicable measured detections) and is also provided in Table 4-9.

Table 4-9. Site-Specific Risk-Based Screening Comparison

Site	# of Failed Screens	Total # of Measured Detections[1]	% of Failed Screens	# of Pollutant Groups Analyzed
S4MO	1,101	5,417	20.32	4
PXSS	1,047	4,862	21.53	4
NBIL	1,023	5,171	19.78	5
TOOK	990	3,546	27.92	3
DEMI	959	4,119	23.28	3
GPCO	955	5,068	18.84	4
TMOK	939	3,566	26.33	3
TROK	938	3,582	26.19	3
BTUT	913	4,672	19.54	5
SEWA	841	4,705	17.87	4
OCOK	825	3,519	23.44	3
CSNJ	819	2,499	32.77	2
YUOK	818	3,470	23.57	3
SPIL	783	2,419	32.37	2
ELNJ	776	2,406	32.25	2
GLKY	770	4,578	16.82	4
BLKY	610	3,158	19.32	2
CHNJ	556	2,000	27.80	2
TVKY	551	2,150	25.63	1
BROK	547	1,816	30.12	4
ATKY	534	2,160	24.72	1
ASKY	476	1,960	24.29	1
LEKY	429	2,307	18.60	2
NRNJ	374	1,319	28.35	2
NBNJ	344	1,156	29.76	2
SPAZ	341	1,017	33.53	1
SKFL	316	1,947	16.23	2
RICO	308	847	36.36	2
NROK	276	821	33.62	4
INDEM	238	357	66.67	1
WPIN	232	348	66.67	1
AZFL	231	357	64.71	1
SYFL	226	335	67.46	1
ROCH	207	1,700	12.18	1
ASKY-M	197	1,097	17.96	1
ORFL	196	294	66.67	1
PACO	196	737	26.59	2
BOMA	194	2,848	6.81	2

[1]Total number of measured detections for all pollutants with screening values, not just those failing screens. Also excludes acrolein, acetonitrile, acrylonitrile, and carbon disulfide results.
BOLD ITALICS = EPA-designated NATTS Site

Table 4-9. Site-Specific Risk-Based Screening Comparison (Continued)

Site	# of Failed Screens	Total # of Measured Detections[1]	% of Failed Screens	# of Pollutant Groups Analyzed
ROIL	194	620	31.29	2
SJJCA	186	2,501	7.44	2
BRCO	179	681	26.28	2
BXNY	163	1,759	9.27	1
GSCO	137	438	31.28	2
CELA	117	1,557	7.51	1
BAKY	113	1,134	9.96	1
WADC	109	1,534	7.11	1
RIVA	106	1,484	7.14	2
PRRI	105	1,684	6.24	1
RFCO	96	464	20.69	2
BMCO	93	347	26.80	2
RUCA	85	1,470	5.78	1
PAFL	55	529	10.40	1
UNVT	2	1,107	0.18	1
Total	23,816	111,639	21.33	

[1]Total number of measured detections for all pollutants with screening values, not just those failing screens. Also excludes acrolein, acetonitrile, acrylonitrile, and carbon disulfide results.
BOLD ITALICS = EPA-designated NATTS Site

As shown, S4MO has the largest number of failed screens (1,101), followed by PXSS (1,047); these two sites also had the largest number of failed screens in 2014. Conversely, concentrations measured at UNVT failed relatively few screens (2). Every NMP site had at least one concentration fail a screen. The total number of screens and the number of pollutant groups measured by each site must be considered when interpreting the results in Table 4-9. Sites sampling four or five pollutant groups tended to have a higher number of failed screens due, at least in part, to the higher number of pollutants (with screening values) sampled. For sites sampling only one or two pollutant groups, it depends on the pollutant group sampled as the number of pollutants analyzed varies from one (hexavalent chromium) to 80 (SNMOCs). Although SYFL, ORFL, INDEM and WPIN have the highest failure rates (67 percent each), these sites sampled only one pollutant group (carbonyl compounds). Three pollutants measured with Method TO-11A (carbonyl compounds) have screening values (acetaldehyde, formaldehyde, and propionaldehyde) and two of these pollutants typically fail all or most of the screens conducted, as shown in Table 4-8. Thus, sites sampling only carbonyl compounds have higher failure rates. Conversely, sites that sampled several pollutant groups tended to have lower failure rates due to the larger number of HAPs screened, as is the case with GLKY and SEWA.

These sites both sampled four pollutant groups and have a failure rate less than 20 percent. Of course, the magnitude of concentrations measured greatly factors into this as well.

The following sections from this point forward focus primarily on those pollutants designated as program-level pollutants of interest.

4.2.1 Concentrations of the Pollutants of Interest

Concentrations of the program-level pollutants of interest vary significantly, among the pollutants and across the sites. Tables 4-10 through 4-13 present the top 10 annual average concentrations and 95 percent confidence intervals by site for each of the program-level pollutants of interest (for VOC/SNMOCs, carbonyl compounds, PAHs, and metals, respectively). As described in Section 3.1, an annual average concentration is the average concentration of all measured detections and zeros substituted for non-detects for a given year. An annual average is only calculated where at least three quarterly averages could be calculated for a given year and where the site-specific method completeness is at least 85 percent. The annual average concentrations in Tables 4-10 and 4-11, for VOC/SNMOCs and carbonyl compounds, respectively, are reported in $\mu g/m^3$ while the annual average concentrations for PAHs and metals, in Tables 4-12 and 4-13, respectively, are reported in ng/m^3 for ease of viewing. Note that not all sites sampled each pollutant group; thus, the list of possible sites presented in Tables 4-10 through 4-13 is limited to those sites sampling each pollutant. For instance, only five sites sampled TSP metals; thus, these would be the only sites to appear in Table 4-13 for each metal (TSP) pollutant of interest shown. Annual average concentrations for 2015 are shaded in gray in Tables 4-10 through 4-13, while annual average concentrations for 2016 are shown in white. Thus, sites sampling during 2015 and 2016 could appear in each table more than once.

Table 4-10. Annual Average Concentration Comparison of the VOC/SNMOC Pollutants of Interest[1]

Rank	Benzene (µg/m³)	1,3-Butadiene (µg/m³)	Carbon Tetrachloride (µg/m³)	*p*-Dichlorobenzene (µg/m³)	1,2-Dichloroethane (µg/m³)	Ethylbenzene (µg/m³)	Hexachloro-1,3-Butadiene (µg/m³)
1	SPAZ 1.33 ± 0.32	TVKY 0.35 ± 0.19	TVKY 0.85 ± 0.13	SPAZ 0.30 ± 0.06	TVKY 3.75 ± 1.56	SPAZ 0.74 ± 0.14	***BTUT*** 0.04 ± 0.04
2	SPAZ 1.28 ± 0.31	SPAZ 0.27 ± 0.10	TVKY 0.80 ± 0.10	SPAZ 0.25 ± 0.06	TVKY 3.49 ± 1.36	SPAZ 0.66 ± 0.15	TMOK 0.03 ± 0.01
3	PACO 1.21 ± 0.16	SPAZ 0.23 ± 0.08	BLKY 0.73 ± 0.04	***S4MO*** 0.22 ± 0.10	BLKY 1.89 ± 1.55	***PXSS*** 0.65 ± 0.11	TROK 0.03 ± 0.01
4	PACO 1.20 ± 0.14	***PXSS*** 0.22 ± 0.05	***SEWA*** 0.70 ± 0.02	***PXSS*** 0.20 ± 0.03	ATKY 0.90 ± 0.55	***PXSS*** 0.54 ± 0.12	NRNJ 0.03 ± 0.01
5	***PXSS*** 1.13 ± 0.19	***PXSS*** 0.20 ± 0.05	ATKY 0.69 ± 0.03	***PXSS*** 0.15 ± 0.03	BLKY 0.72 ± 0.29	TOOK 0.47 ± 0.08	BLKY 0.03 ± 0.01
6	RICO 1.10 ± 0.14	TVKY 0.16 ± 0.12	ATKY 0.67 ± 0.03	***S4MO*** 0.14 ± 0.04	ATKY 0.41 ± 0.19	CSNJ 0.47 ± 0.09	***PXSS*** 0.03 ± 0.01
7	TOOK 1.09 ± 0.12	ELNJ 0.12 ± 0.02	***SEWA*** 0.67 ± 0.02	***NBIL*** 0.13 ± 0.11	TMOK 0.10 ± 0.01	TMOK 0.44 ± 0.08	TOOK 0.02 ± 0.01
8	TOOK 1.08 ± 0.13	SPIL 0.12 ± 0.02	BLKY 0.67 ± 0.03	TMOK 0.08 ± 0.02	TOOK 0.10 ± 0.01	CSNJ 0.42 ± 0.06	ATKY 0.02 ± 0.01
9	***PXSS*** 1.04 ± 0.21	ELNJ 0.12 ± 0.02	***DEMI*** 0.67 ± 0.02	CSNJ 0.06 ± 0.02	TROK 0.10 ± 0.01	TROK 0.41 ± 0.07	CSNJ 0.02 ± 0.01
10	TVKY 1.04 ± 0.30	SPIL 0.11 ± 0.01	***DEMI*** 0.66 ± 0.03	TMOK 0.06 ± 0.01	BROK 0.09 ± 0.01	TOOK 0.40 ± 0.06	***NBIL*** 0.02 ± 0.01

BOLD ITALICS = EPA-designated NATTS Site

[1] Annual average concentrations for 2015 are shaded in gray, while those for 2016 are in white.

Table 4-11. Annual Average Concentration Comparison of the Carbonyl Compound Pollutants of Interest[1]

Rank	Acetaldehyde (µg/m^3)	Formaldehyde (µg/m^3)
1	BROK 4.06 ± 1.42	***BTUT*** 8.42 ± 1.37
2	***BTUT*** 3.64 ± 0.48	AZFL 7.31 ± 1.85
3	***PXSS*** 2.75 ± 0.28	***BTUT*** 5.68 ± 0.72
4	CSNJ 2.65 ± 0.37	BROK 4.95 ± 1.59
5	***BTUT*** 2.62 ± 0.31	***SKFL*** 4.72 ± 1.29
6	ELNJ 2.50 ± 0.26	ELNJ 4.43 ± 0.41
7	ELNJ 2.49 ± 0.31	ELNJ 4.38 ± 0.68
8	SPIL 2.45 ± 0.61	CSNJ 4.06 ± 0.43
9	SPIL 2.43 ± 0.52	SPIL 3.85 ± 0.45
10	NBNJ 2.03 ± 0.20	***PXSS*** 3.80 ± 0.27

BOLD ITALICS = EPA-designated NATTS Site

[1] Annual average concentrations for 2015 are shaded in gray, while those for 2016 are in white.

Table 4-12. Annual Average Concentration Comparison of the PAH Pollutants of Interest[1]

Rank	Acenaphthene (ng/m^3)	Fluorene (ng/m^3)	Naphthalene (ng/m^3)
1	***NBIL*** 18.93 ± 6.15	***NBIL*** 19.19 ± 6.42	***DEMI*** 116.18 ± 15.46
2	***NBIL*** 17.48 ± 5.88	***NBIL*** 16.27 ± 5.41	***BXNY*** 113.05 ± 12.40
3	***ROCH*** 17.37 ± 4.25	***ROCH*** 13.07 ± 3.08	***DEMI*** 107.01 ± 14.51
4	***ROCH*** 13.81 ± 3.80	***ROCH*** 11.71 ± 3.14	***BXNY*** 93.29 ± 10.96
5	***DEMI*** 10.30 ± 3.05	***DEMI*** 9.57 ± 2.69	***GPCO*** 91.01 ± 12.89
6	***DEMI*** 8.86 ± 2.14	***DEMI*** 7.93 ± 1.69	***NBIL*** 89.32 ± 22.07
7	***GPCO*** 8.29 ± 3.97	***GPCO*** 7.33 ± 3.80	***NBIL*** 79.55 ± 17.47
8	***S4MO*** 6.51 ± 1.47	***S4MO*** 6.67 ± 1.81	***CELA*** 78.40 ± 9.06
9	***S4MO*** 6.13 ± 1.71	***BXNY*** 6.61 ± 1.30	***S4MO*** 78.32 ± 11.77
10	***GPCO*** 5.67 ± 1.20	***S4MO*** 6.40 ± 1.31	***CELA*** 76.85 ± 9.42

BOLD ITALICS = EPA-designated NATTS Site

[1] Annual average concentrations for 2015 are shaded in gray, while those for 2016 are in white.

Table 4-13. Annual Average Concentration Comparison of the Metals Pollutants of Interest[1]

Rank	Arsenic (PM_{10}) (ng/m^3)	Arsenic (TSP) (ng/m^3)
1	ASKY-M 1.38 ± 0.32	TROK 0.95 ± 0.20
2	ASKY-M 1.13 ± 0.23	TOOK 0.89 ± 0.11
3	BAKY 0.97 ± 0.19	TROK 0.85 ± 0.14
4	***NBIL*** 0.94 ± 0.27	TOOK 0.78 ± 0.08
5	BAKY 0.92 ± 0.15	TMOK 0.67 ± 0.08
6	***S4MO*** 0.90 ± 0.13	TMOK 0.64 ± 0.07
7	***S4MO*** 0.88 ± 0.12	OCOK 0.56 ± 0.07
8	***NBIL*** 0.87 ± 0.13	YUOK 0.55 ± 0.09
9	LEKY 0.81 ± 0.17	YUOK 0.54 ± 0.08
10	***SEWA*** 0.77 ± 0.16	OCOK 0.51 ± 0.06

BOLD ITALICS = EPA-designated NATTS Site

[1] Annual average concentrations for 2015 are shaded in gray, while those for 2016 are in white.

Observations from Tables 4-10 through 4-13 include the following:

- The highest annual average concentration among the program-wide pollutants of interest was calculated for formaldehyde for BTUT for 2015 (8.42 ± 1.37 $\mu g/m^3$). BTUT's 2016 annual average is less (5.68 ± 0.72 $\mu g/m^3$), but still ranks third highest among annual average formaldehyde concentrations. Annual average concentrations of formaldehyde for BTUT have topped this list for the last several NMP reports. Formaldehyde accounts for 25 of the 29 annual average concentrations greater than 3.0 $\mu g/m^3$ shown in Tables 4-10 through 4-13 (with 1,2-dichloroethane and acetaldehyde accounting for two each).

- Among the VOCs shown in Table 4-10, the highest annual average concentrations were calculated for 1,2-dichloroethane for TVKY (3.75 ± 1.56 $\mu g/m^3$ for 2015 and 3.49 ± 1.36 $\mu g/m^3$ for 2016). Only one other NMP site sampling this pollutant has an annual average concentration greater than 1 $\mu g/m^3$ (BLKY, 1.89 ± 1.55 $\mu g/m^3$ for 2016) and no NMP site outside of Calvert City, Kentucky has an annual average concentration of this pollutant greater than 0.10 $\mu g/m^3$. While the Calvert City, Kentucky sites (ATKY, BLKY, and TVKY) account for the six highest annual average concentrations of this pollutant in Table 4-10, their averages are also quite variable.

- Benzene is the only other VOC shown in Table 4-10 with annual average concentrations greater than 1 $\mu g/m^3$. In fact, all 10 annual average concentrations of benzene shown in Table 4-10 are greater than 1 $\mu g/m^3$. The annual average concentrations for both years appear in Table 4-10 for most of the sites shown. For example, SPAZ has the two highest annual average benzene concentrations, 1.33 ± 0.32 $\mu g/m^3$ for 2016 and 1.28 ± 0.31 $\mu g/m^3$ for 2015. PACO, PXSS, and TOOK also appear for both years. RICO (shown for 2015) and TVKY (shown for 2015) are the exceptions. Note that the annual average benzene concentrations for SPAZ have the largest confidence intervals associated with them. It is worth noting that VOC samples were collected on a 1-in-12 day sampling schedule at SPAZ, compared to a 1-in-6 day schedule for the other sites.

- The highest annual average concentration of 1,3-butadiene (0.35 ± 0.19 $\mu g/m^3$) was calculated for TVKY for 2015 and is very similar to the annual average calculated for this site for 2014. TVKY's 2016 annual average concentration of 1,3-butadiene (0.16 ± 0.12 $\mu g/m^3$) is less than half the 2015 annual average for this site but still ranks sixth highest among sites sampling this pollutant. Both the 2015 and 2016 annual average concentrations of 1,3-butadiene rank in the top 10 for the five sites shown in Table 4-10. Note the relatively large confidence intervals associated with the annual average concentrations for TVKY. This site has the highest measurements of 1,3-butadiene across the program; of the 10 1,3-butadiene concentrations greater than 1 $\mu g/m^3$ measured across the program, nine were measured at TVKY (seven in 2015 and two in 2016). The annual average concentrations of 1,3-butadiene for the two Phoenix, Arizona sites rank second, third, fourth, and fifth (each of which lies between 0.20 $\mu g/m^3$ and 0.30 $\mu g/m^3$) among sites sampling this pollutant.

- The highest annual average concentrations of carbon tetrachloride were also calculated for TVKY (0.85 ± 0.13 $\mu g/m^3$ for 2015 and 0.80 ± 0.10 $\mu g/m^3$ for 2016). Calvert City, Kentucky sites account for six of the 10 highest annual average concentrations of carbon tetrachloride. Most of the annual average concentrations of carbon tetrachloride do not vary significantly across NMP sites; less than 0.10 $\mu g/m^3$ separates most of the annual average carbon tetrachloride concentrations across the program. Only TVKY has an annual average concentration greater than 0.75 $\mu g/m^3$, with most lying between 0.6 $\mu g/m^3$ and 0.7 $\mu g/m^3$. Measurements of carbon tetrachloride collected at Calvert City sites account for the 28 highest carbon tetrachloride concentrations measured across the program, including 22 measurements greater than 1 $\mu g/m^3$. Annual average concentrations for SEWA and DEMI account for the remaining annual averages of carbon tetrachloride shown in Table 4-10.

- Similar to 2014, and previous years, SPAZ has the highest annual average concentrations of *p*-dichlorobenzene among NMP sites sampling this pollutant. The two Phoenix, Arizona sites account for four of the five highest annual average concentrations of *p*-dichlorobenzene shown in Table 4-10.

- The three Calvert City, Kentucky sites account for the six highest annual average concentrations of 1,2-dichloroethane, although the averages vary significantly among them, ranging from 3.75 ± 1.56 $\mu g/m^3$ for TVKY for 2015 to 0.41 ± 0.19 $\mu g/m^3$ for ATKY for 2015. All other NMP sites have annual average 1,2-dichloroethane

concentrations of 0.10 µg/m^3 or less, including the four Oklahoma sites rounding out the top 10 annual averages shown in Table 4-10. The three sites Calvert City account for the all but one of the 176 measurements of 1,2-dichloroethane greater than 0.25 µg/m^3 measured across the program, with these measurements ranging from 0.251 µg/m^3 to 45.8 µg/m^3.

- The Phoenix, Arizona sites also have the four highest annual average concentrations of ethylbenzene across the program, with the remaining annual average concentrations shown in Table 4-10 less than 0.5 µg/m^3. These sites also ranked highest for ethylbenzene in the 2014 NMP report. The only other sites with annual average concentrations of ethylbenzene greater than or equal to 0.4 µg/m^3 are located in Tulsa, Oklahoma (TOOK TMOK, or TROK) or Camden, New Jersey (CSNJ).

- The annual average concentrations of hexachloro-1,3-butadiene shown in Table 4-10 were calculated based on 2016 data. This is due to a standard contamination issue that was found in 2015, as discussed in Section 2.4, resulting in the invalidation of a large portion of the 2015 data for this pollutant. Hexachloro-1,3-butadiene is the only VOC in Table 4-10 that does not have at least one annual average concentration greater than 0.1 µg/m^3. BTUT has the highest annual average concentration of this pollutant (0.04 ± 0.04 µg/m^3), although the range of annual average concentrations of hexachloro-1,3-butadiene is relatively small, varying by 0.02 µg/m^3 across the sites shown and by 0.04 µg/m^3 across all NMP sites.

- Many of the sites shown in Table 4-11 for the highest annual average concentrations of acetaldehyde are the same as the sites shown for formaldehyde. For example, BTUT's 2015 annual average concentration of formaldehyde ranks highest among sites sampling this pollutant; BTUT's 2015 annual average concentration of acetaldehyde ranks second highest among sites sampling this pollutant. BTUT's 2016 annual average concentrations of both pollutants also rank the in top five in Table 4-11. There are exceptions, however. BROK's 2015 annual average is the highest annual average concentration of acetaldehyde shown in Table 4-11, and BROK's 2015 annual average concentration formaldehyde ranks fourth highest, yet neither 2016 annual average appears in Table 4-11. For both pollutants, the annual average concentration for BROK for 2015 is more than twice the annual average for 2016 (4.06 ± 1.42 µg/m^3 for 2015 vs. 1.46 ± 0.14 µg/m^3 for 2016 for acetaldehyde and 4.95 ± 1.59 µg/m^3 for 2015 vs. 2.07 ± 0.30 µg/m^3 for 2016 for formaldehyde). The differences in the confidence intervals for the annual averages for each year indicates that the concentrations measured in 2015 are highly variable and are likely influences by outliers. Similarly, AZFL's 2016 annual average concentration of formaldehyde (7.31 ± 1.85 µg/m^3) is more than four times greater than its 2015 annual average concentration of formaldehyde (1.79 ± 0.18 µg/m^3). The significant difference between the two annual average concentrations for AZFL (and BROK) is discussed in detail in the individual state sections.

- Annual average concentrations of acetaldehyde shown in Table 4-11 vary from 4.06 ± 1.42 µg/m^3 for BROK (2015) to 2.03 ± 0.20 µg/m^3 for NBNJ (2015). Four individual acetaldehyde concentrations greater than 15 µg/m^3 were measured in 2015, three at BROK and one at SPIL; none were measured in 2016 (although an acetaldehyde concentration of 14.8 µg/m^3 was measured at SPIL in 2016).

- Annual average formaldehyde concentrations shown in Table 4-11 vary from 8.42 ± 1.37 µg/m^3 for BTUT (2015) to 3.80 ± 0.27 µg/m^3 for PXSS (2016). As shown, there are eight annual average concentrations of formaldehyde greater than 4 µg/m^3, yet this is only true for two NMP sites for both years (BTUT and ELNJ). The 2015 and 2016 annual average concentrations of formaldehyde for ELNJ are similar to each other while the annual averages for BTUT are less so.

- There are three PAH program-wide pollutant of interest, as shown in Table 4-12. All sites sampling PAHs under the NMP in 2015 and 2016 were NATTS sites.

- There is considerable agreement in the ranking of the highest annual average concentrations of acenaphthene and fluorene among the sites shown. For example, NBIL's 2016 annual average concentrations of both pollutants rank highest, followed by NBIL's 2015 annual averages; ROCH's 2015 annual average concentrations of both pollutants rank third highest, followed by ROCH's 2016 annual averages; and DEMI's 2016 annual average concentrations of both pollutants rank fifth highest, followed by DEMI's 2015 annual averages.

- Table 4-12 shows that the range of the 10 highest annual average concentrations of naphthalene varies considerably, from 116.18 ± 15.46 ng/m^3 for DEMI (2015) to 76.85 ± 9.42 ng/m^3 for CELA (2015), with three annual average concentrations of naphthalene greater than 100 ng/m^3. DEMI also had the highest annual average concentration of naphthalene in the 2014 NMP report. The three highest individual naphthalene concentrations, including one greater than 400 ng/m^3, were measured at NBIL. In total, six measurements of naphthalene greater than 300 ng/m^3 were measured across the program (five in 2015 and two in 2016).

- ASKY-M has the highest annual average concentration of arsenic, similar to the 2014 and 2013 NMP reports. This site has the only annual average concentrations of arsenic greater than 1 ng/m^3 (1.38 ± 0.32 ng/m^3 for 2015 and 1.13 ± 0.23 ng/m^3 for 2016). Three of the five Kentucky sites sampling PM_{10} metals (and where annual average concentrations could be calculated) appear in Table 4-13 for arsenic (BLKY and GLKY are the exceptions). Both years' annual average concentrations of arsenic for S4MO and NBIL also appear in Table 4-13. Annual averages of arsenic for S4MO consistently rank among the highest in past annual reports.

- Among the Oklahoma sites sampling TSP metals, the annual average concentrations of arsenic for the three Tulsa sites ranked higher than the annual averages for the Oklahoma City sites. The 2016 annual average concentration of arsenic for TROK (0.95 ± 0.20 ng/m^3) is the highest among the sites sampling TSP metals.

- Annual average concentrations for PXSS appear in Tables 4-10 through 4-13 the most, a total of 11 times, followed by DEMI, NBIL, and SPAZ (at 8 appearances each), TVKY and S4MO (at 7 each), and TOOK, CSNJ, and ELNJ (at 6 each). The two Phoenix, Arizona sites appear in Table 4-10 a combined 19 times; the three Calvert City, Kentucky sites appear in Table 4-10 a combined 17 times; and the Tulsa, Oklahoma sites appear a combined 14 times.

4.2.2 Variability Analysis for the Pollutants of Interest

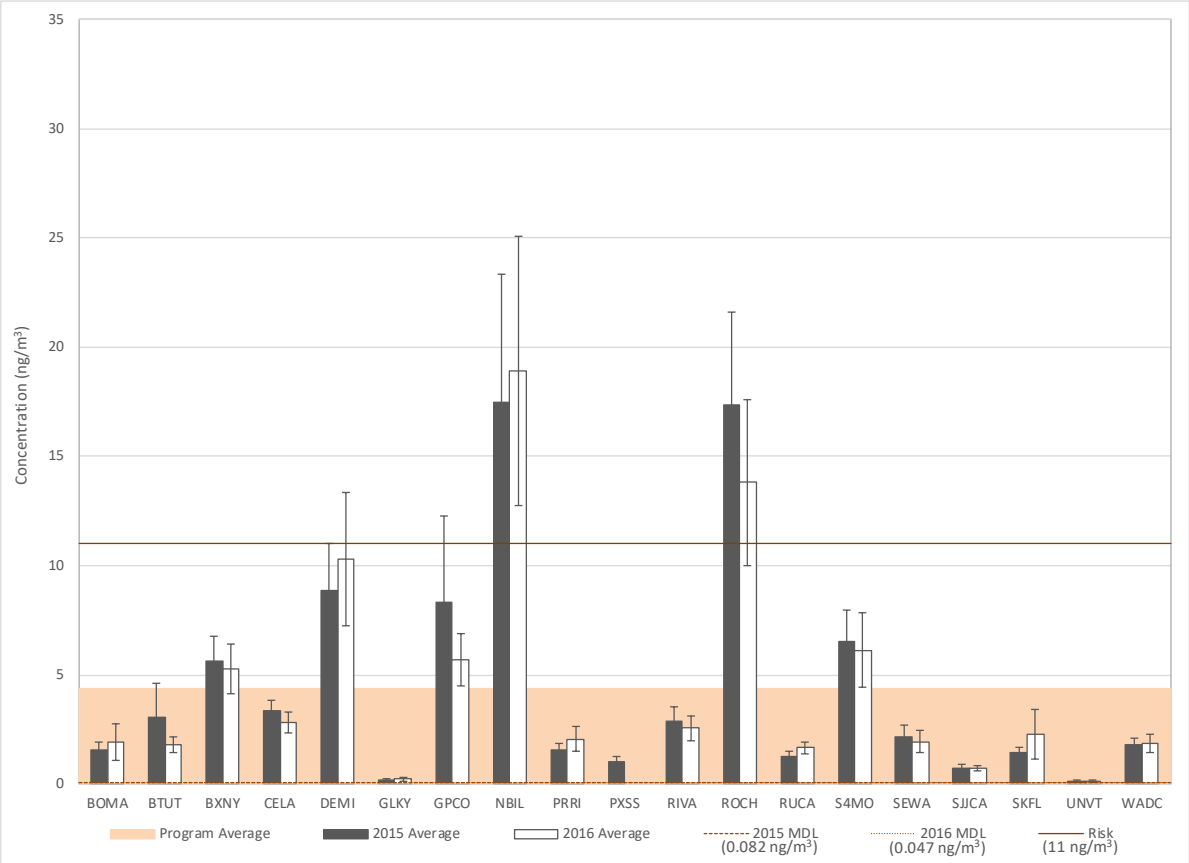
This section presents the results of the two variability analyses described in Section 3.3.

4.2.2.1 Inter-site Variability

Figures 4-1 through 4-12 are bar graphs depicting the site-specific annual averages for each year (in gray for 2015 and in white for 2016) overlain on the program-level averages, for both years combined (indicated by the solid shading), as presented in Section 4.1. For each program-level pollutant of interest, the inter-site variability graphs allow the reader to see how the individual site-specific annual average concentrations feed into the program-level averages (e.g., if a specific site(s) is driving the program average). In addition, the confidence intervals provided on the inter-site variability graphs are an indication of the amount of variability contained within the site-specific dataset and thus, annual average concentrations. The published MDL for each year from the ERG laboratory is also plotted on the graph as an indication of how the data fall in relation to the MDL. The preliminary risk-based screening values are also plotted on the graphs.

Several items to note about these figures: Some sites do not have annual average concentrations presented on the inter-site variability graphs because they did not meet the criteria for the calculation of annual averages specified in Section 3.1. For the sites sampling metals, the program-level average for sites collecting PM_{10} samples is presented in green while the program-level average for sites collecting TSP samples is presented in pink. For benzene, 1,3-butadiene, and ethylbenzene, the three pollutants sampled and analyzed with two methods (VOC and SNMOC) and identified as program-level pollutants of interest, two graphs are presented, one for each method. Note that BTUT and NBIL have their canister samples analyzed using both TO-15 and SNMOC methods. While both results are shown in this section, only the VOC results are discussed throughout the remainder of this report, as described in Section 3.2. The exception is for RFCO; canister samples collected at RFCO were analyzed with both methods between January and September 2015, after which only the SNMOC analysis was performed. This too is discussed in Section 3.2.

Figure 4-1. Inter-Site Variability for Acenaphthene



Observations from Figure 4-1 include the following:

- Figure 4-1 presents the program-level and site-specific annual average concentrations of acenaphthene.

- The program-level average concentration of acenaphthene is 4.36 ± 0.37 ng/m^3, as shown in orange in Figure 4-1. Site-specific annual average concentrations range from 0.12 ± 0.06 ng/m^3 (UNVT, 2015) to 18.93 ± 6.15 ng/m^3 (NBIL, 2016).

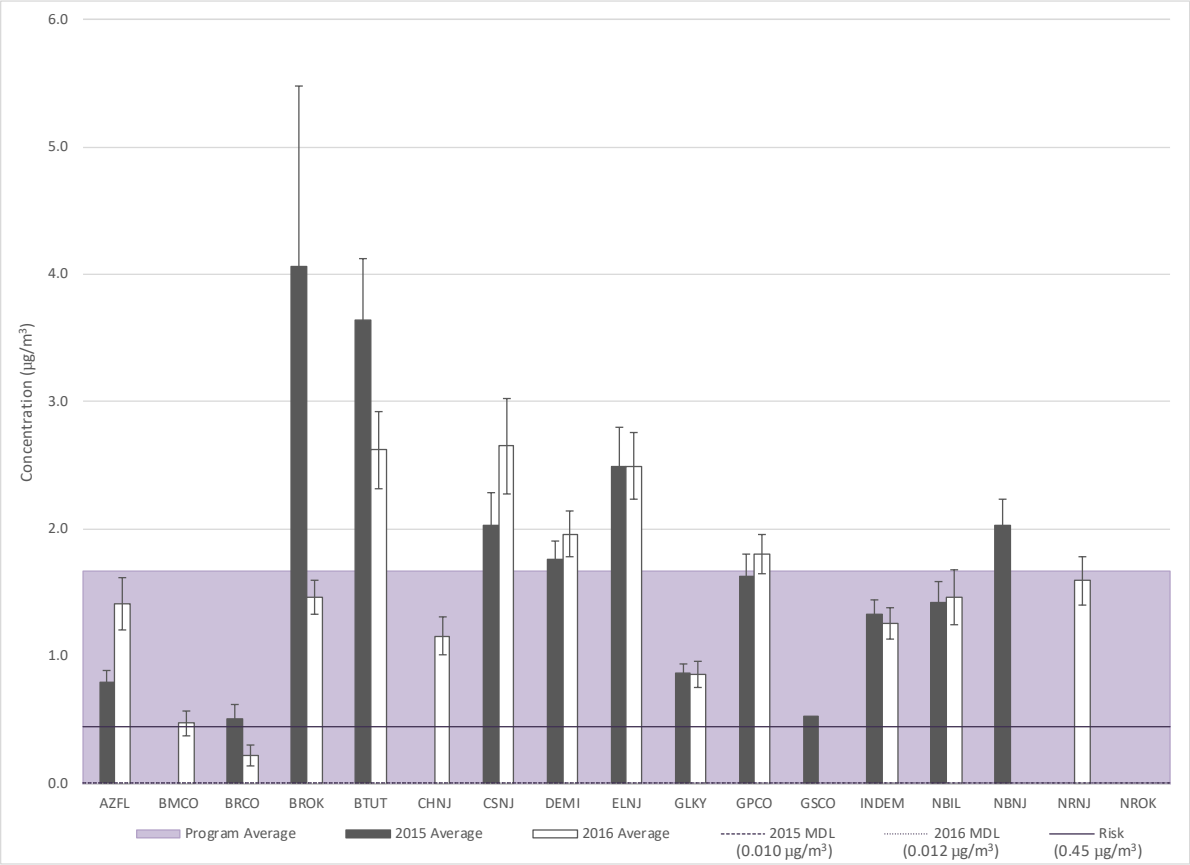
- Both annual average concentrations of acenaphthene for NBIL are more than four times the program-level average concentration for acenaphthene. Both of ROCH's annual average concentrations are also considerably greater than the program-level average concentration of acenaphthene. The confidence intervals associated with these (and several other) annual average concentrations indicate that there is considerable variability within the measurements.

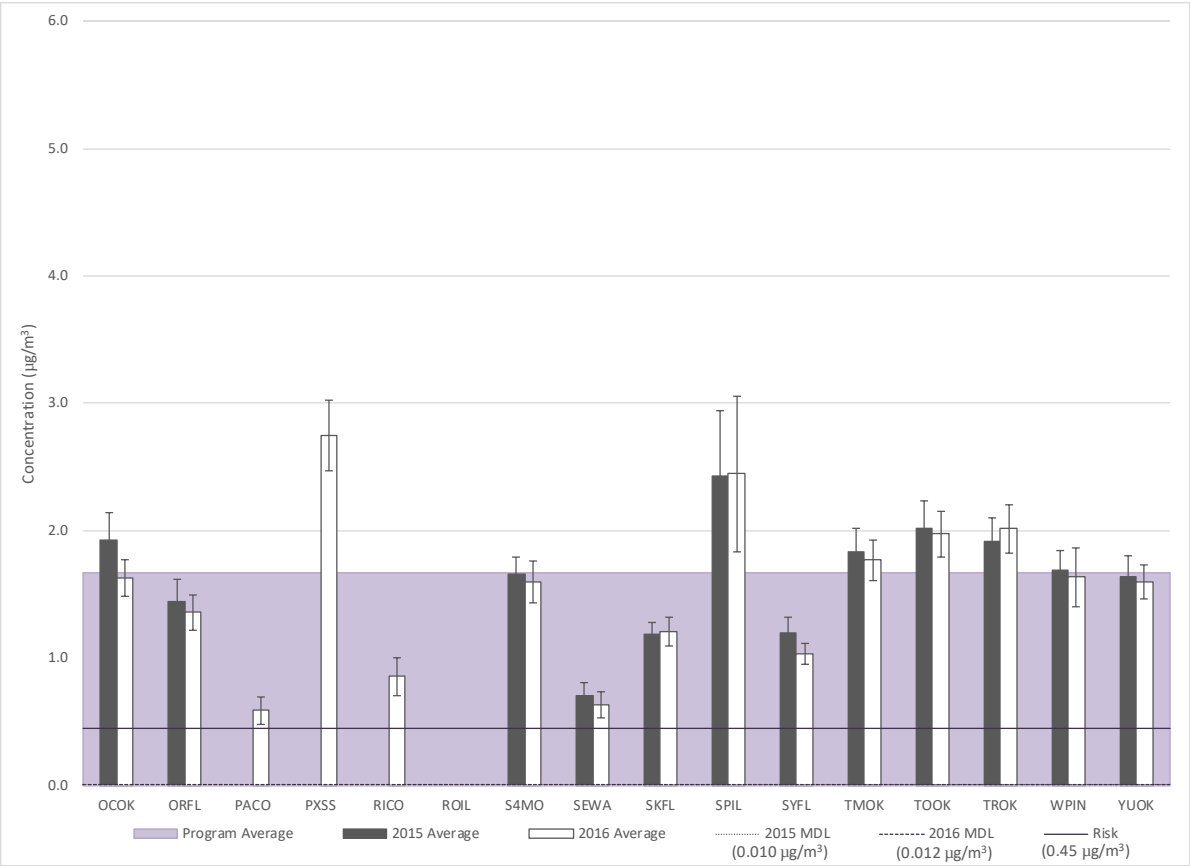
- Other sites with annual average concentrations greater than the program-level average include BXNY, DEMI, GPCO, and S4MO.

- Sites with relatively low annual average concentrations (less than 1 ng/m^3) other than UNVT include GLKY and SJJCA.

- An annual average concentration could not be calculated for PXSS for 2016 due to issues with the collection system resulting in relatively low completeness.

Figure 4-2. Inter-Site Variability for Acetaldehyde





Observations from Figure 4-2 include the following:

- Figure 4-2 presents the program-level and site-specific annual average concentrations of acetaldehyde.

- The program-level average concentration of acetaldehyde is 1.67 ± 0.04 µg/m^3, as shown in purple in Figure 4-2.

- Site-specific annual average concentrations range from 0.22 ± 0.08 µg/m^3 (BRCO, 2016) to 4.06 ± 1.42 µg/m^3 (BROK, 2015).

- The 2015 annual average concentration of acetaldehyde for BROK is nearly two and half times the program-level average concentration for acetaldehyde. BROK's annual average for 2015 is nearly three times greater than the annual average for 2016 for this site. The confidence intervals associated with the 2015 annual average concentration of acetaldehyde for BROK indicate that there are likely outliers affecting this dataset.

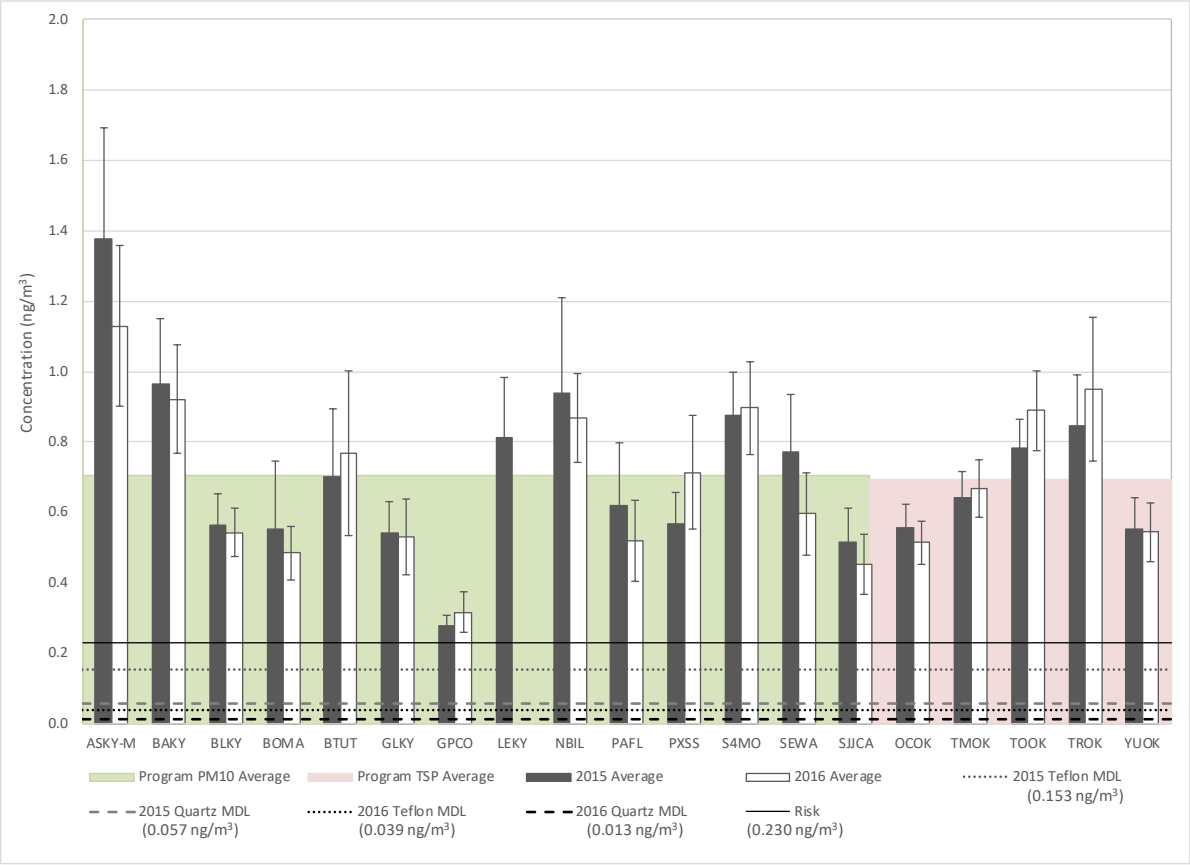
- Other sites with annual average concentrations greater than the program-level average include BTUT, CSNJ, DEMI, ELNJ, GPCO (2016 only), NBNJ (2015 only), OCOK (2015 only), PXSS (2016 only), SPIL, TMOK, TOOK, TROK, and WPIN (2015 only).

- Besides BROK (in 2015), SPIL, BTUT, CSNJ, and ELNJ have the most variability associated with their measurements, as indicated by the confidence intervals shown.

- Sites with relatively low annual average concentrations (less than 1 µg/m^3) include BRCO, BMCO, GSCO, PACO, SEWA, AZFL (2015), RICO, and GLKY.

- Annual averages could not be calculated for BMCO, CHNJ, NRNJ, PACO, PXSS, and RICO for 2015; GSCO and NBNJ for 2016; and NROK and ROIL for either year. Note, however, the relocation of the NBNJ collection system to NRNJ in 2016, the relocation of the BMCO collection system to GSCO in 2015 and back again in 2016, the initiation of sampling at NROK in 2016, and the discontinuation of sampling at ROIL in mid-2015.

Figure 4-3. Inter-Site Variability for Arsenic



Observations from Figure 4-3 include the following:

- Figure 4-3 presents the inter-site variability graph for arsenic, which also includes a comparison of PM_{10} results (green) and TSP results (pink). Note that only sites from Oklahoma are using TSP collection systems.

- The program-level average concentration of arsenic in PM_{10} is similar to the program-level average concentration of arsenic in TSP, with a PM_{10} average of 0.703 ± 0.032 ng/m^3 and a TSP average of 0.695 ± 0.036 ng/m^3.

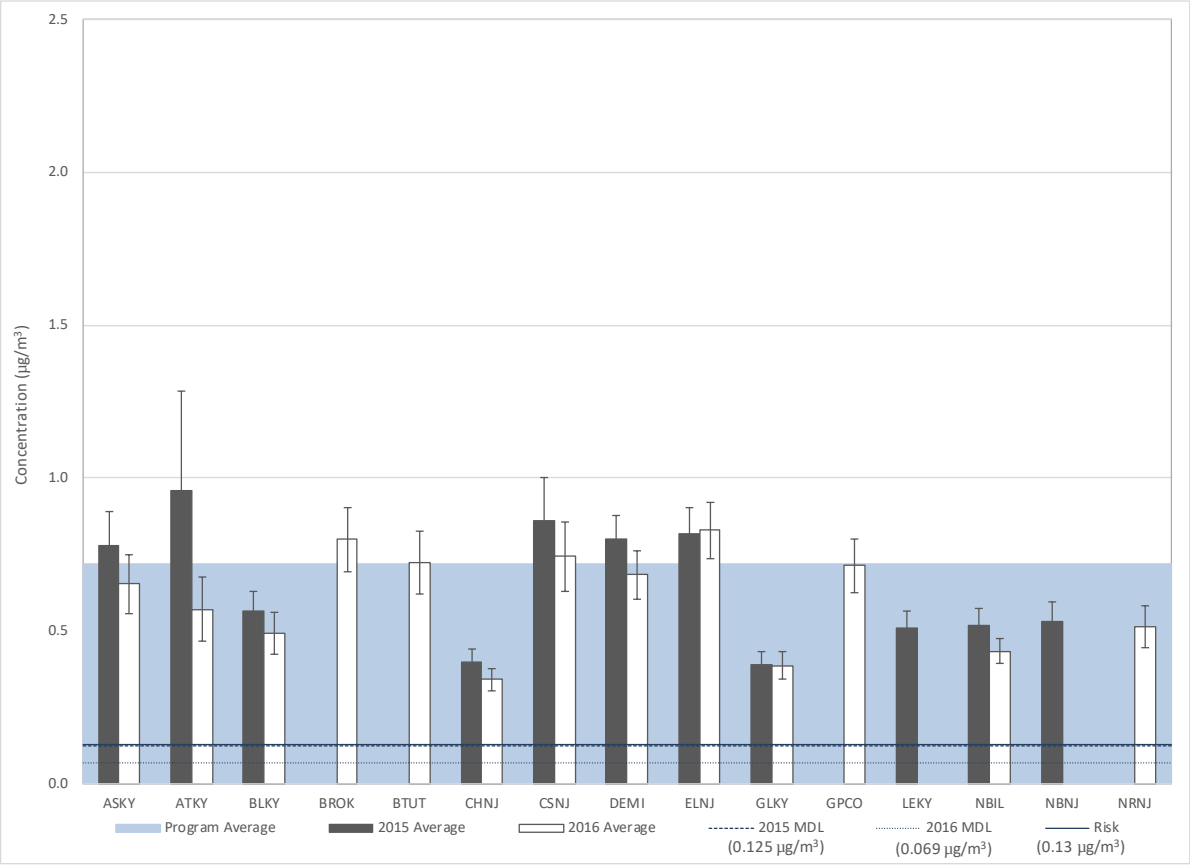
- Site-specific annual average arsenic concentrations for PM_{10} range from 0.28 ± 0.03 ng/m^3 (GPCO, 2015) to 1.38 ± 0.32 ng/m^3 (ASKY-M, 2015) and from 0.51 ± 0.06 ng/m^3 (OCOK, 2016) to 0.95 ± 0.20 ng/m^3 (TROK, 2016) for TSP.

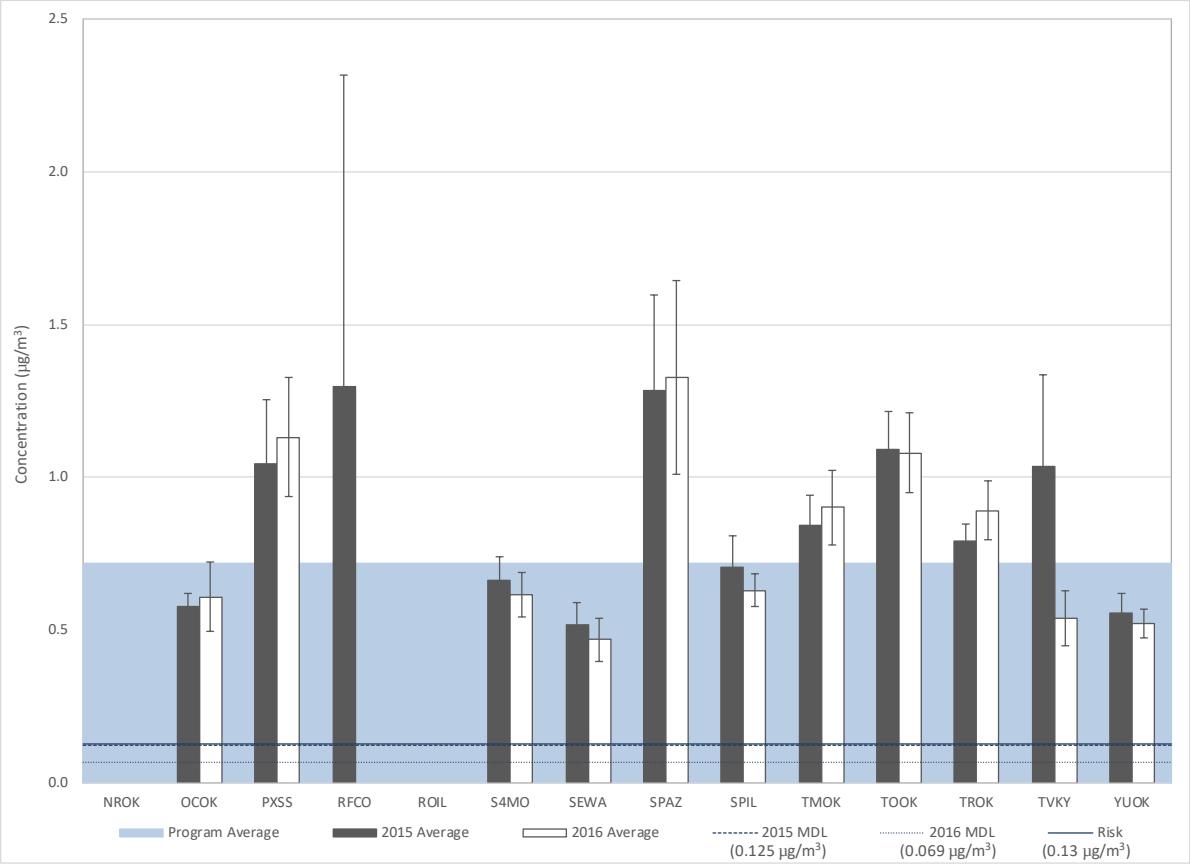
- ASKY-M, NBIL, and BTUT have the most variability in the PM_{10} measurements, while TROK has the most variability in the TSP measurements.

- Most of the annual average concentrations of arsenic are within a 0.5 ng/m^3 window (between 0.4 ng/m^3 and 0.9 ng/m^3). Those sites with annul averages greater than 0.9 ng/m^3 include ASKY-M, BAKY, NBIL (2015 only), and TROK (2016 only). GPCO is the only site with annual average concentrations less than 0.4 ng/m^3.

- An annual average could not be calculated for LEKY in 2016 because the completeness criteria was not met.

Figure 4-4a. Inter-Site Variability for Benzene – Method TO-15





Observations from Figure 4-4a include the following:

- Figure 4-4a is the inter-site variability graph for benzene, as measured with Method TO-15. (Figure 4-4b presents the inter-site variability graph for benzene, as measured with the SNMOC method.)

- The program-level average concentration of benzene (TO-15 only) is 0.72 ± 0.02 µg/m^3.

- Site-specific annual average benzene concentrations range from 0.34 ± 0.04 µg/m^3 (CHNJ, 2016) to 1.33 ± 0.32 µg/m^3 (SPAZ, 2016).

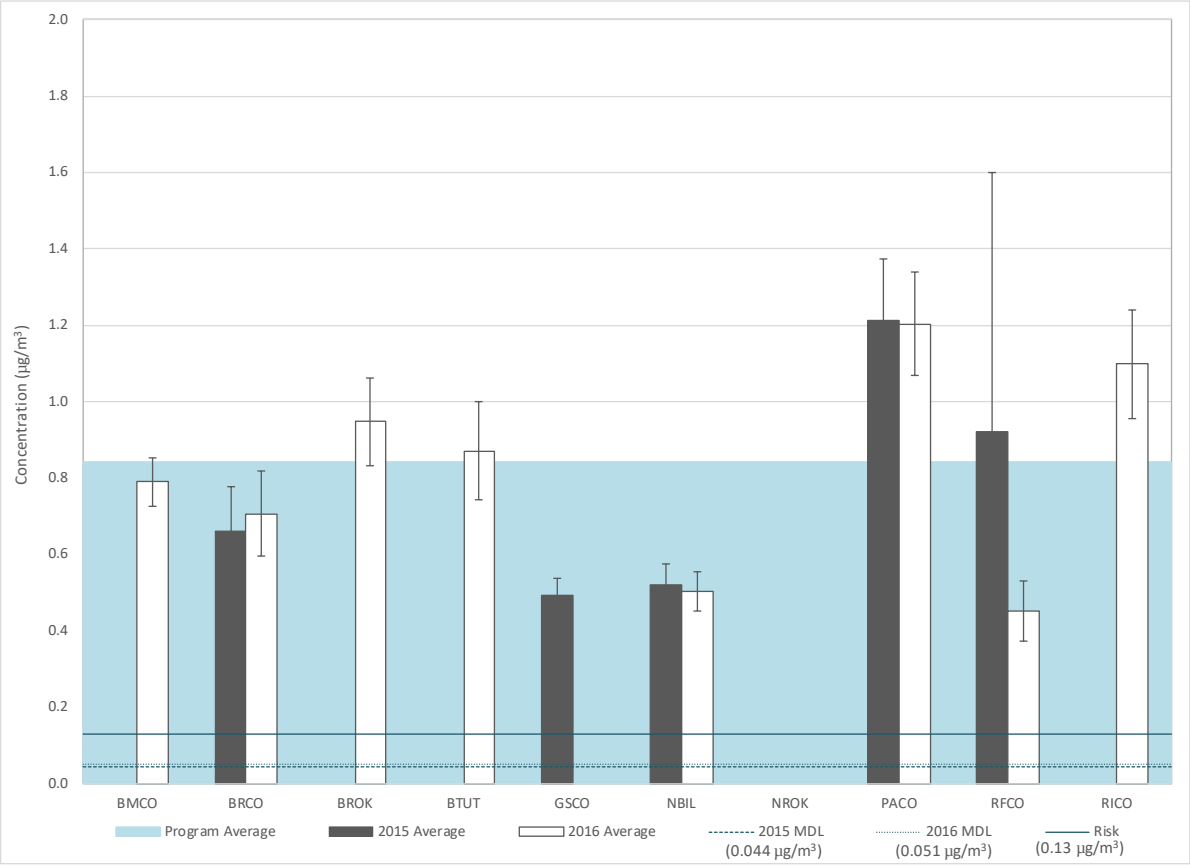
- Other sites measuring benzene with Method TO-15 with annual average concentrations greater than 1 µg/m^3 include RFCO (2015), PXSS, TOOK, and TVKY (2015). Sites with relatively low annual average concentrations of benzene (less than 0.5 µg/m^3) include CHNJ, GLKY, NBIL (2016), SEWA (2016), and BLKY (2016).

- RFCO (2015), ATKY (2015), SPAZ, TVKY (2015), and PXSS have the most variability associated with the benzene measurements collected, as indicated by the relatively large confidence intervals shown in Figure 4-4a.

- Annual averages could not be calculated for BROK, BTUT, GPCO, and NRNJ for 2015; LEKY and NBNJ for 2016; and NROK and ROIL for either year. Note, however, the relocation of the NBNJ collection system to NRNJ in 2016, the initiation of sampling at BROK in 2015 and NROK in 2016, and the discontinuation of sampling at ROIL in mid-2015 and at LEKY in mid-2016.

- Sampling and analysis of benzene was performed with both Methods TO-15 and SNMOC for canister samples collected at RFCO between January and September 2015, after which only the SNMOC method was used. As a result, the annual average benzene concentration for RFCO with Method TO-15 is presented here, although the annual average concentration of benzene presented for this site for the remainder of the report is from the SNMOC method.

Figure 4-4b. Inter-Site Variability for Benzene – SNMOC



Observations from Figure 4-4b include the following:

- Figure 4-4b is the inter-site variability graph for benzene, as measured with the SNMOC method. Canister samples collected at 10 sites are analyzed with this method.

- The program-level average concentration of benzene (SNMOC only) is 0.84 ± 0.04 µg/m^3. Site-specific annual average concentrations of benzene (SNMOC only) range from 0.45 ± 0.08 µg/m^3 (RFCO, 2016) to 1.21 ± 0.16 µg/m^3 (PACO, 2015).

- PACO's annual average concentrations of benzene for both 2015 and 2016 are similar to each other, both of which are greater than 1 µg/m^3. RICO's annual average for 2016 is also greater than 1 µg/m^3, but no annual average could be calculated for 2015. Annual average concentrations for GSCO, NBIL, and RFCO (2016) are considerably less.

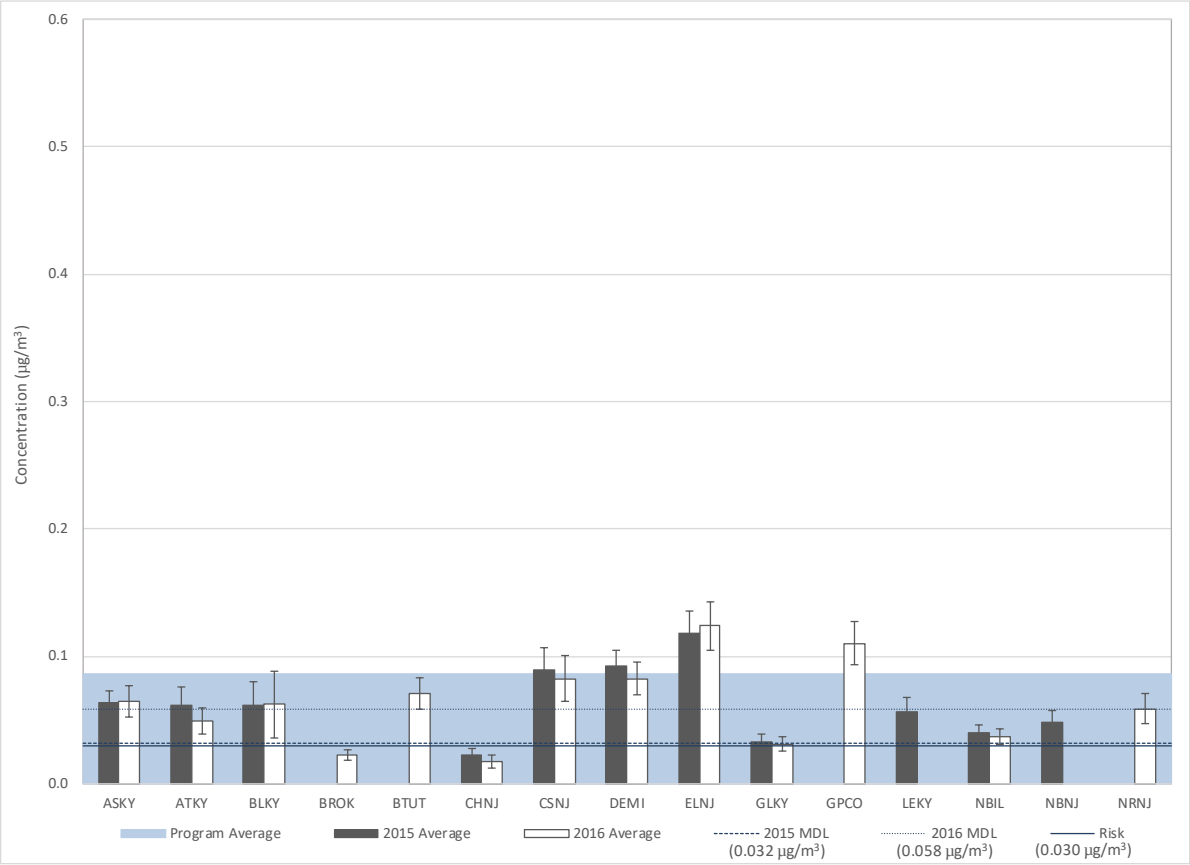
- Note the differences in the annual average concentrations of benzene for RFCO. The annual average for 2016 (0.45 ± 0.08 µg/m^3) is half the magnitude of the annual average for 2015 (0.92 ± 0.68 µg/m^3). The confidence intervals associated with the annual average concentration for 2015 suggest that outliers may be affecting this annual average concentration. RFCO's average for 2015 shown in Figure 4-4a for Method TO-15 also reflects a significant level of variability.

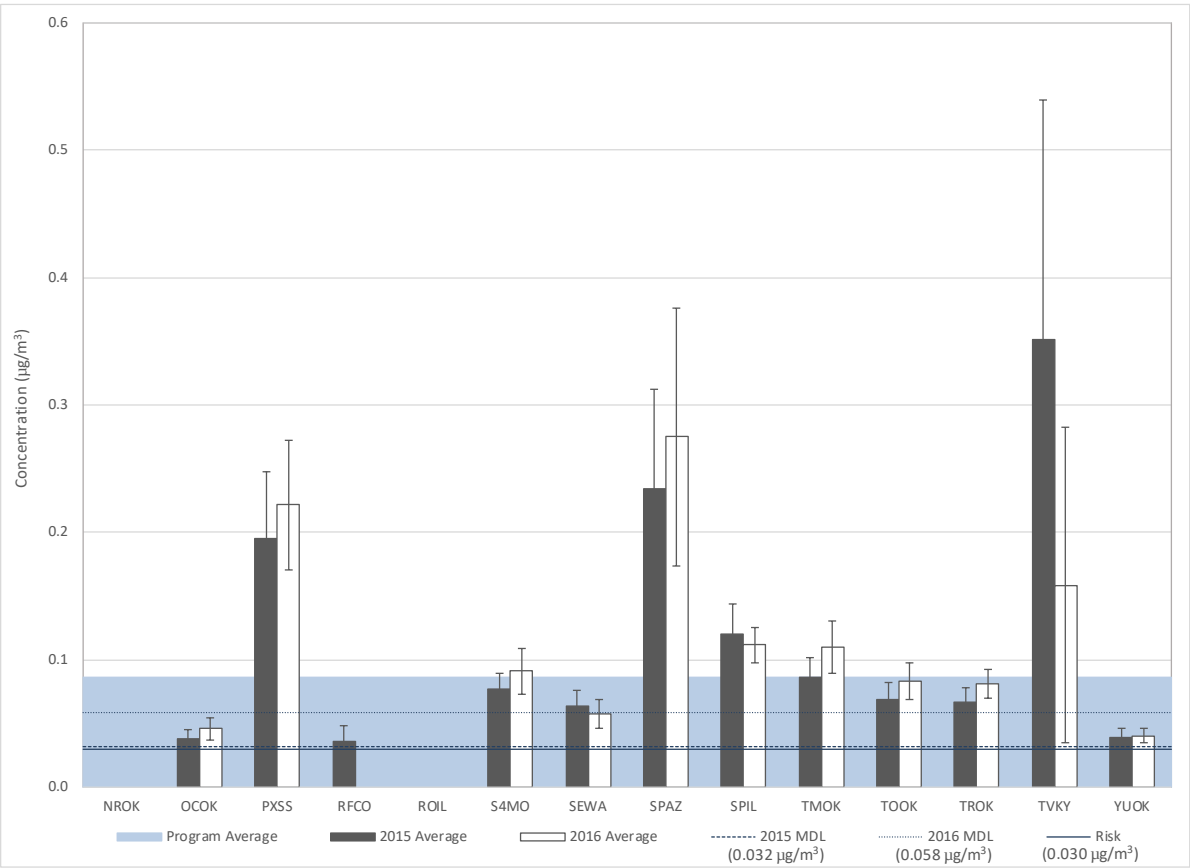
- Less than half of the sites shown in Figure 4-4b have annual average concentrations of benzene shown for both years. Note the initiation of sampling at BROK in 2015 and NROK in 2016, and the relocation of the BMCO collection system to GSCO in 2015 and back again in 2016. RICO experienced issues with the collection system resulting in relatively low completeness in 2015. In addition, co-elution affected some of the samples during analysis, such that some benzene concentrations could not be determined.

- Note that canisters from BTUT and NBIL were analyzed using both analytical methods and their annual average benzene concentrations are similar, although slightly higher, using the SNMOC method. The annual average concentrations of benzene presented for these two sites for the remainder of the report is from Method TO-15.

- Canisters were also analyzed with both methods for RFCO between January and September 2015. However, the because the time frame of collection is different (SNMOC – all year, TO-15 – January through September 2015 only), the averages shown should not be compared directly. The annual average concentrations of benzene presented for this site for the remainder of the report are from the SNMOC method.

Figure 4-5a. Inter-Site Variability for 1,3-Butadiene – Method TO-15





Observations from Figure 4-5a include the following:

- Figure 4-5a is the inter-site variability graph for 1,3-butadiene, as measured with Method TO-15. (Figure 4-5b presents the inter-site variability graph for 1,3-butadiene, as measured with the SNMOC method.)

- The program-level average concentration of 1,3-butadiene (TO-15 only) is 0.086 ± 0.006 µg/m^3.

- Site-specific annual average 1,3-butadiene concentrations range from $0.02 \pm <0.01$ µg/m^3 (CHNJ, 2016) to 0.35 ± 0.19 µg/m^3 (TVKY, 2015).

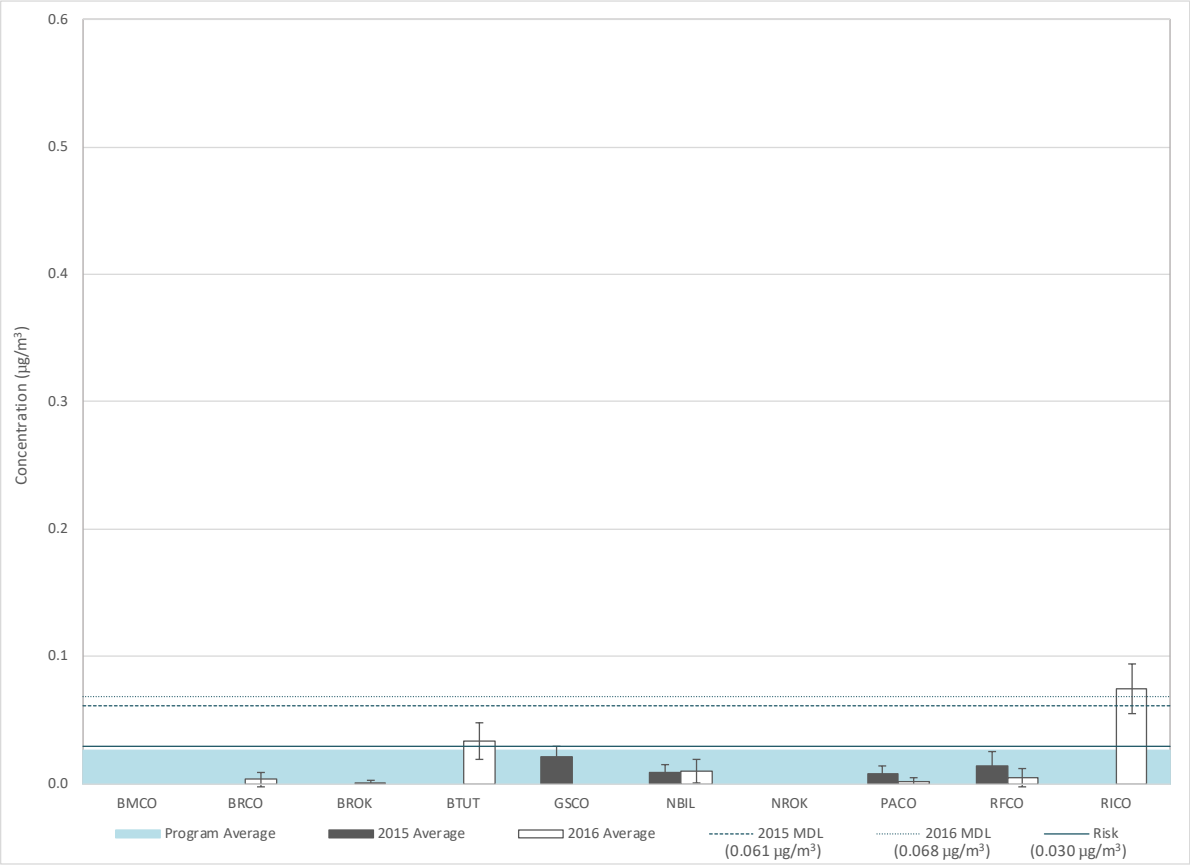
- Figure 4-5a shows that the annual average concentrations for a few sites are considerably higher than most other sites. The annual average concentrations for PXSS, SPAZ, and TVKY stand out the most in this figure. These sites also have the most variability associated with their 1,3-butadiene measurements, as indicated by the confidence intervals shown in Figure 4-5a.

- Many sites' annual average concentrations are less than the program-level average concentration, including some whose annual average is also less than the MDLs shown, including BROK (2016) and CHNJ. Note the difference between the 2015 (0.032 µg/m^3) and 2016 (0.058 µg/m^3) MDLs for this pollutant.

- Annual averages could not be calculated for BROK, BTUT, GPCO, and NRNJ for 2015; LEKY and NBNJ for 2016; and NROK and ROIL for either year. Note, however, the relocation of the NBNJ collection system to NRNJ in 2016, the initiation of sampling at BROK in 2015 and NROK in 2016, and the discontinuation of sampling at ROIL in mid-2015 and at LEKY in mid-2016.

- Sampling and analysis of 1,3-butadiene was performed with both Methods TO-15 and SNMOC for canisters collected at RFCO between January and September 2015, after which only the SNMOC method was used. As a result, the annual average 1,3-butadiene concentration for RFCO with Method TO-15 is presented here, although the annual average concentration of 1,3-butadiene presented for this site for the remainder of the report is from the SNMOC method.

Figure 4-5b. Inter-Site Variability for 1,3-Butadiene – SNMOC



Observations from Figure 4-5b include the following:

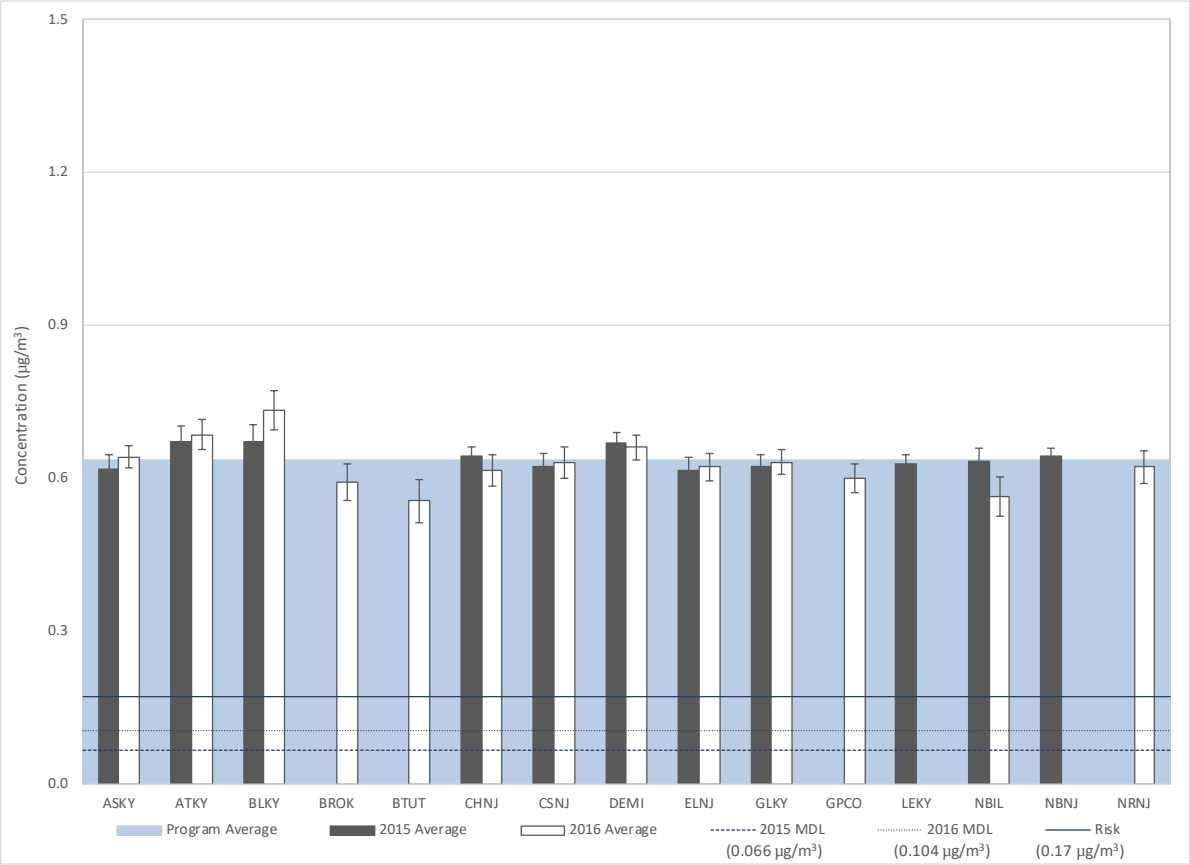
- Figure 4-5b is the inter-site variability graph for 1,3-butadiene, as measured with the SNMOC method. Canister samples collected at 10 sites are analyzed with this method. Note that the scale in this figure is aligned with Figure 4-5a.

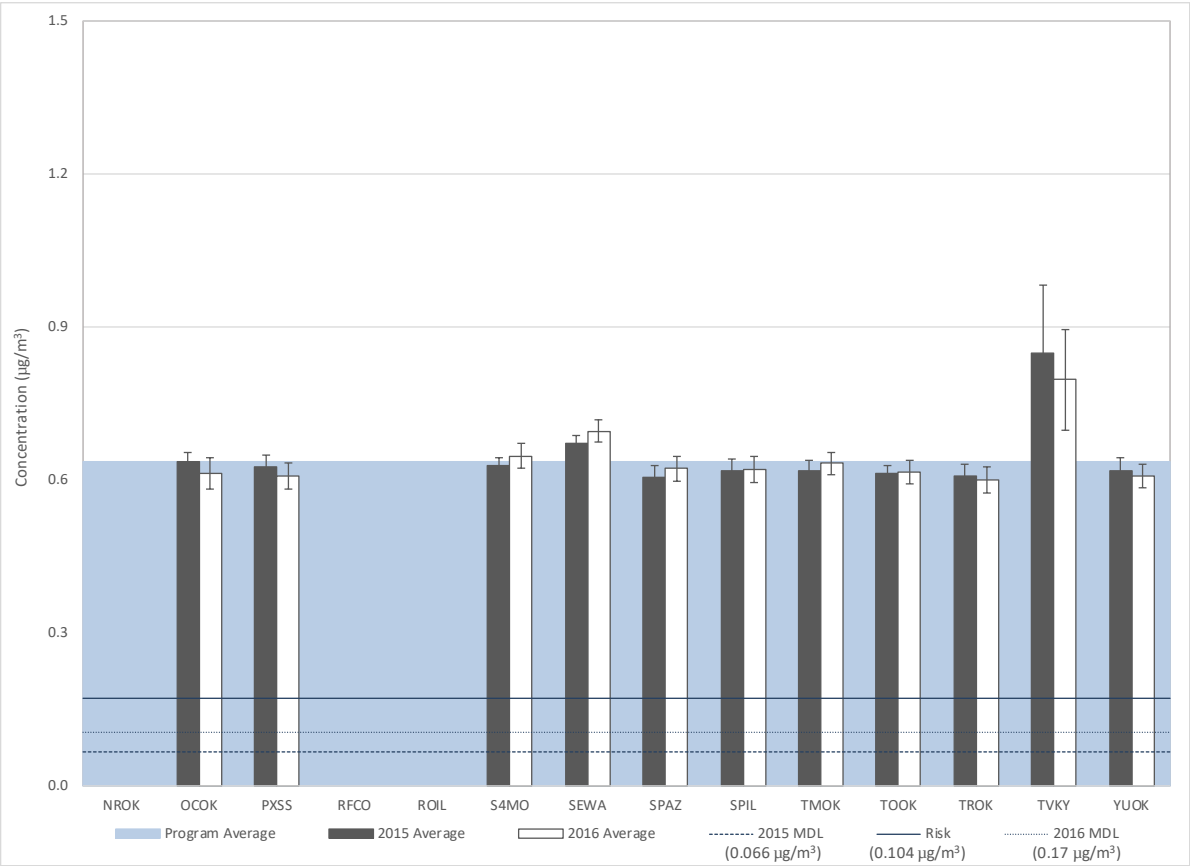
- The program-level average concentration of 1,3-butadiene (SNMOC only) is 0.026 ± 0.004 µg/m^3. Site-specific annual average concentrations of 1,3-butadiene (SNMOC only) range from 0 µg/m^3 (i.e., no detects at BRCO in 2015 and BMCO in 2016) to 0.074 ± 0.020 µg/m^3 (RICO, 2016). RICO's annual average concentration of 1,3-butadiene for 2016 is the only annual average greater than the MDLs for this pollutant.

- Few of the sites in Figure 4-5b have annual average concentrations of 1,3-butadiene shown for either or both years. In some cases, as noted above, this is due to a lack of measured detections of 1,3-butadiene (i.e., the average is at or close to zero). In other cases, this is due to a lack of or change in sampling. Note the initiation of sampling at BROK in 2015 and NROK in 2016, and the relocation of the BMCO collection system to GSCO in 2015 and back again in 2016. In still other cases, this is due to not meeting the completeness criteria established in Section 3.2. BTUT and RICO experienced issues with the collection system resulting in relatively low completeness in 2015.

- Canisters were analyzed with both methods for RFCO between January and September 2015. However, because the time frame of collection is different (SNMOC – all year, TO-15 – January through September 2015 only), the averages shown should not be compared directly. The annual average concentrations of 1,3-butadiene presented for this site for the remainder of the report are from the SNMOC method.

Figure 4-6. Inter-Site Variability for Carbon Tetrachloride





Observations from Figure 4-6 include the following:

- Figure 4-6 is the inter-site variability graph for carbon tetrachloride, as measured with Method TO-15.

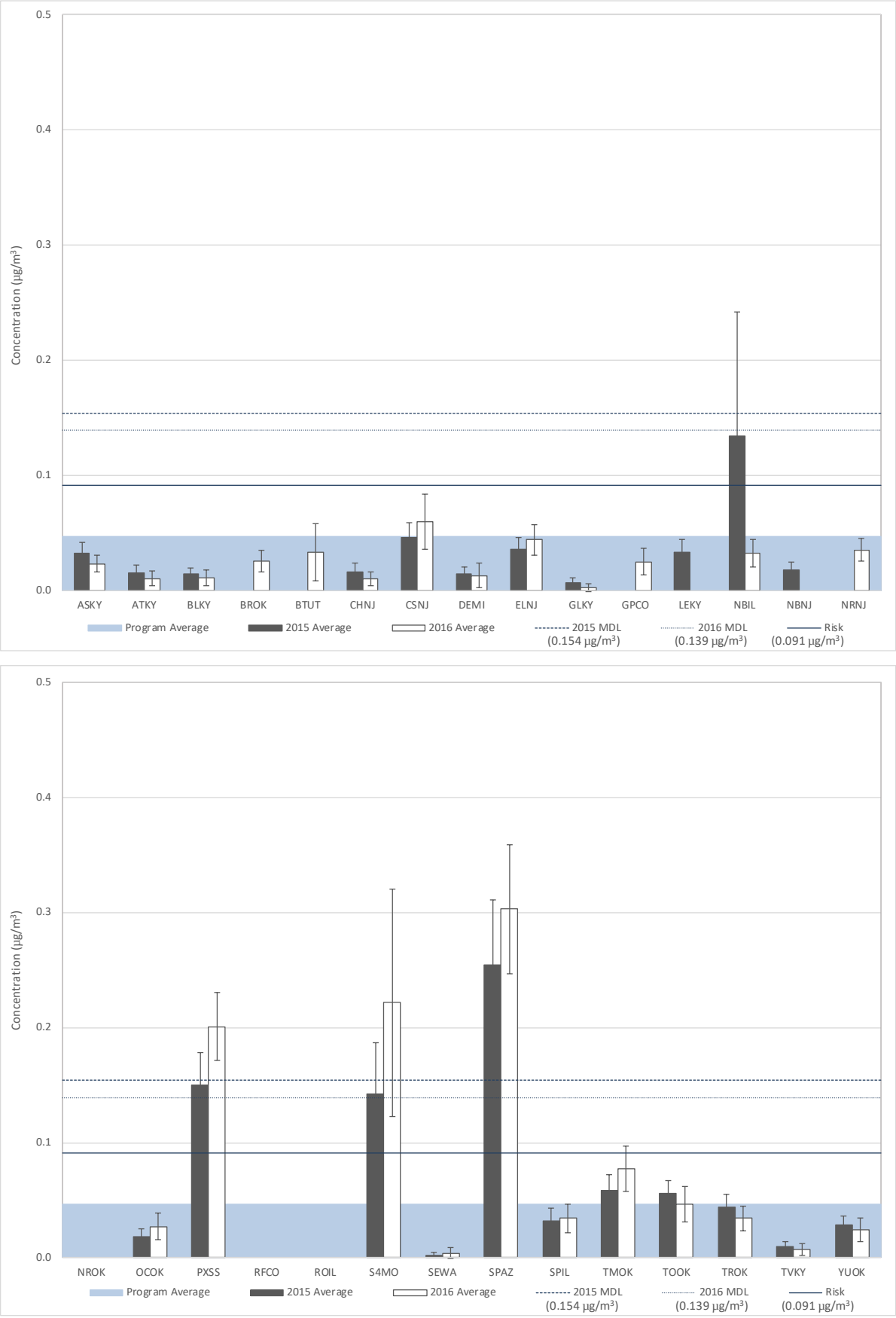
- The program-level average concentration of carbon tetrachloride is 0.64 ± 0.01 µg/m^3, as shown in blue in Figure 4-6.

- For most sites, the annual average concentrations are either slightly less or slightly more than the program-level average concentration and the associated confidence intervals are relatively small. This indicates that there is little variability in the carbon tetrachloride concentrations measured across the program. This uniformity is expected. Carbon tetrachloride is a pollutant that was used worldwide as a refrigerant. However, it was identified as an ozone-depleting substance in the stratosphere and its use was banned by the Montreal Protocol (EPA, 2017f). This pollutant has a long lifetime in the atmosphere, but slowly degrades over time. Today, its concentration in ambient air is fairly ubiquitous regardless of where it is measured.

- The annual average carbon tetrachloride concentrations for several of the Calvert City, Kentucky sites are greater than annual averages for the remaining sites, particularly for TVKY. Most of the annual average concentrations of carbon tetrachloride range from 0.60 µg/m^3 to 0.70 µg/m^3, with annual averages for only TVKY and BLKY (2016) falling outside this range. In addition, the confidence intervals shown for these sites are relatively large, particularly for TVKY, indicating a higher level of variability in the measurements compared to most other NMP sites.

- Annual averages could not be calculated for a number of sites (and years), including BROK, BTUT, GPCO, and NRNJ for 2015; LEKY and NBNJ for 2016; and NROK and ROIL for either year. Note, however, the relocation of the NBNJ collection system to NRNJ in 2016, the initiation of sampling at BROK in 2015 and NROK in 2016, and the discontinuation of sampling at ROIL in mid-2015 and at LEKY in mid-2016.

Figure 4-7. Inter-Site Variability for *p*-Dichlorobenzene



Observations from Figure 4-7 include the following:

- Figure 4-7 is the inter-site variability graph for p-dichlorobenzene, as measured with Method TO-15.

- The program-level average concentration (0.047 ± 0.004 µg/m^3) and most of the site-specific annual average concentrations are less than the MDLs shown for this pollutant (0.154 µg/m^3 for 2015, 0.139 µg/m^3 for 2016), as indicated by the dashed blue lines. This indicates that many of the measurements are either non-detects or less than the detection limit. Table 4-1 shows that more than half of the 2015-2016 measurements of *p*-dichlorobenzene are non-detects and of the measured detections, 83 percent were less than the MDL.

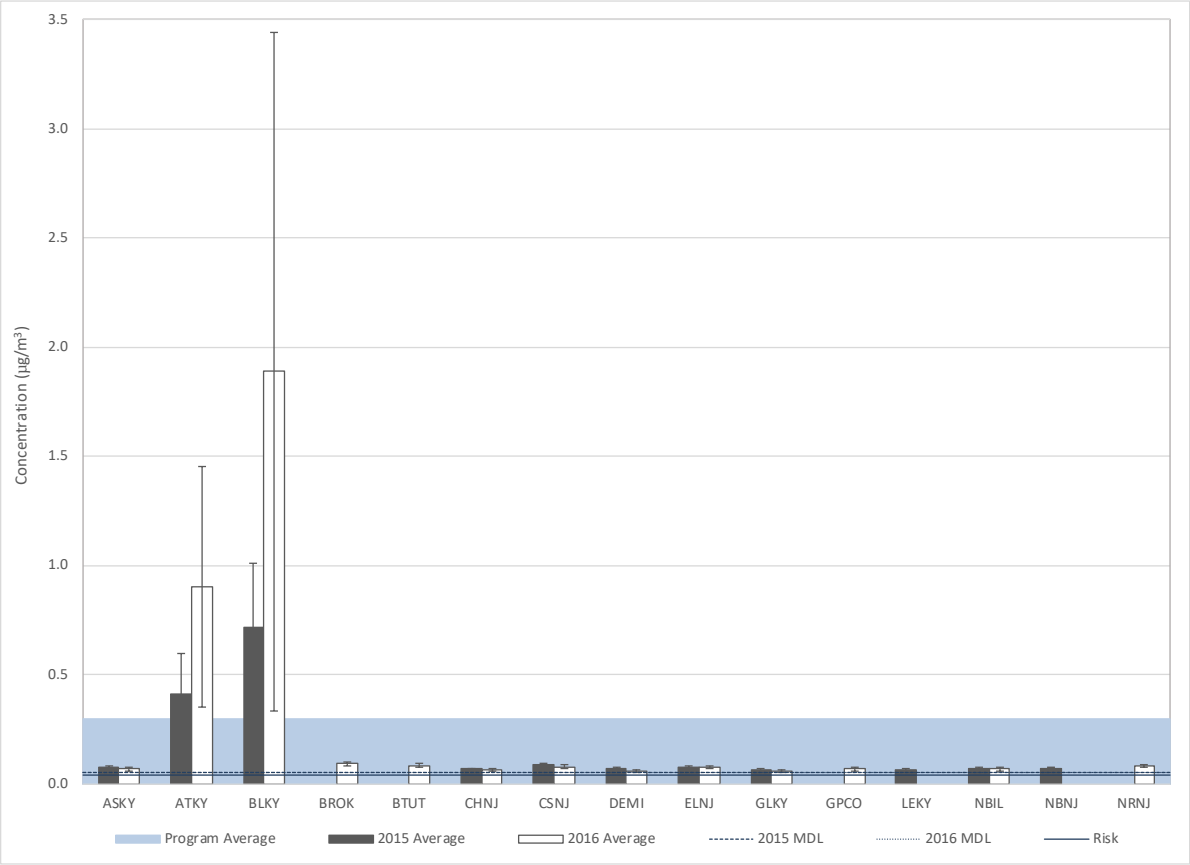
- SPAZ is the only site for which both annual average concentrations of *p*-dichlorobenzene are greater than both MDLs for this pollutant. The annual average concentrations for SPAZ, PXSS, and S4MO (both years) and NBIL (2015 only) are considerably higher than the other annual averages shown in Figure 4-7. Each of these annual average concentrations has a considerable level of variability associated with each average, as indicated by the large confidence intervals.

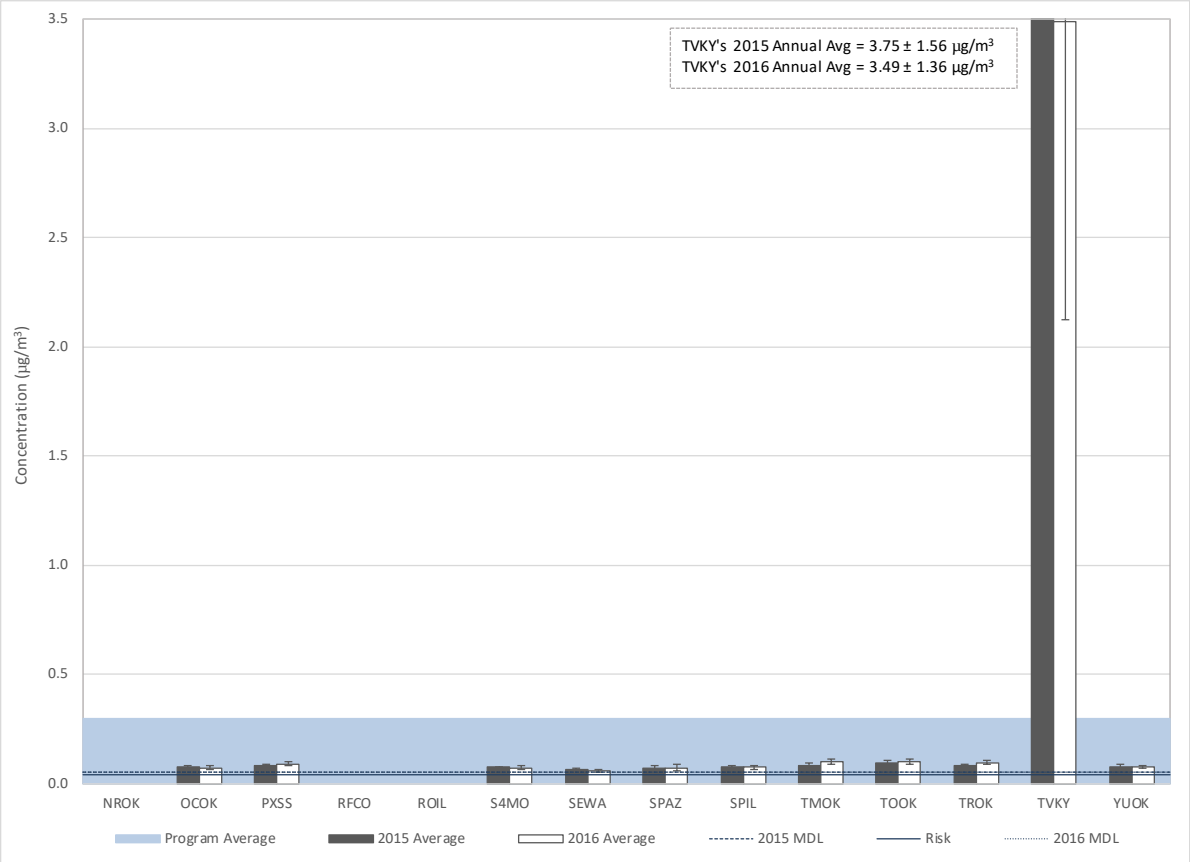
- PXSS is the only site with more than 100 measured detections of *p*-dichlorobenzene (112), although S4MO is close (97). Other sites with a relatively higher number of measured detections include the three Tulsa, Oklahoma sites, CSNJ, ELNJ, and SPAZ.

- The maximum *p*-dichlorobenzene concentration measured across the program was measured at NBIL (2.78 µg/m^3); four additional *p*-dichlorobenzene concentrations greater than 1 µg/m^3 were measured at S4MO (ranging from 1.02 µg/m^3 to 1.80 µg/m^3). Concentrations of *p*-dichlorobenzene greater than 0.5 µg/m^3 were measured at only five sites, S4MO (9), NBIL (4), SPAZ (3), PXSS (2), and BTUT (1).

- Annual averages could not be calculated for a number of sites (and years), including BROK, BTUT, GPCO, and NRNJ for 2015; LEKY and NBNJ for 2016; and NROK and ROIL for either year. Note, however, the relocation of the NBNJ collection system to NRNJ in 2016, the initiation of sampling at BROK in 2015 and NROK in 2016, and the discontinuation of sampling at ROIL in mid-2015 and at LEKY in mid-2016.

Figure 4-8. Inter-Site Variability for 1,2-Dichloroethane





Observations from Figure 4-8 include the following:

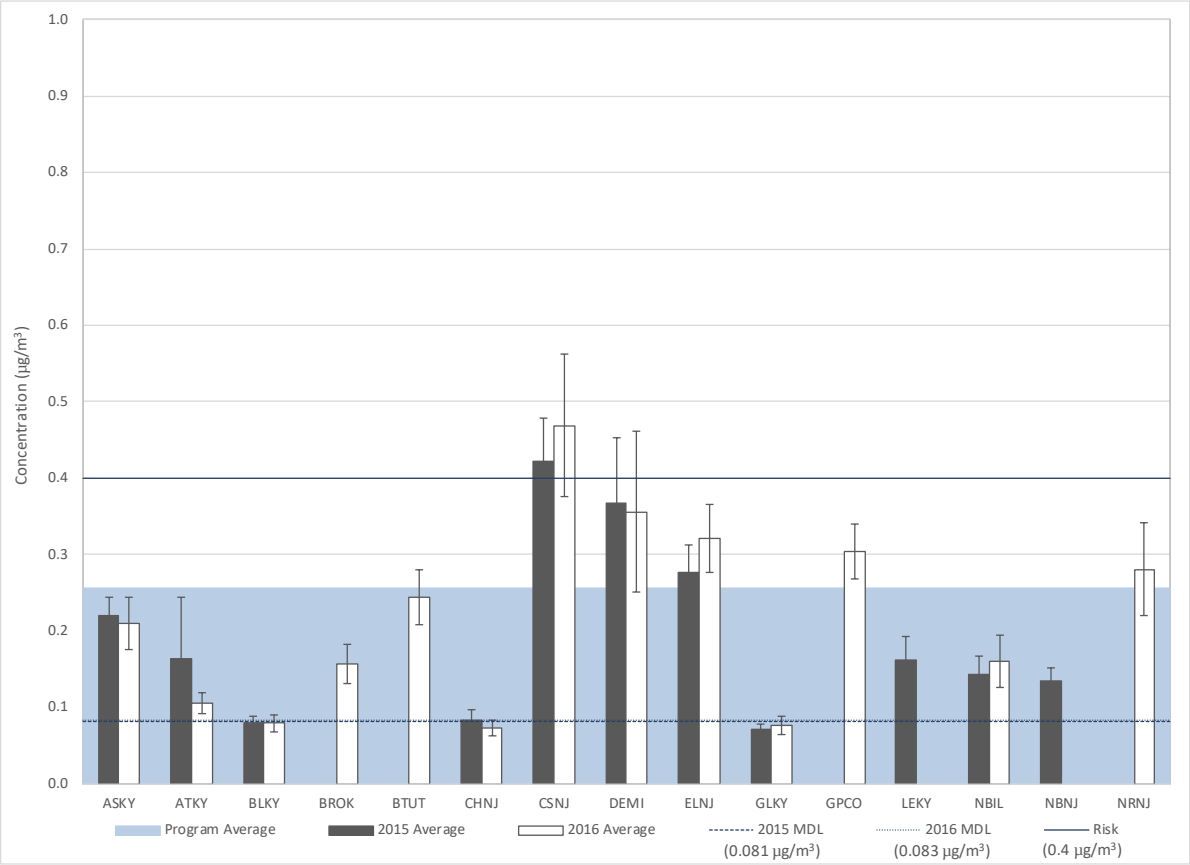
- Figure 4-8 is the inter-site variability graph for 1,2-dichloroethane, as measured with Method TO-15.

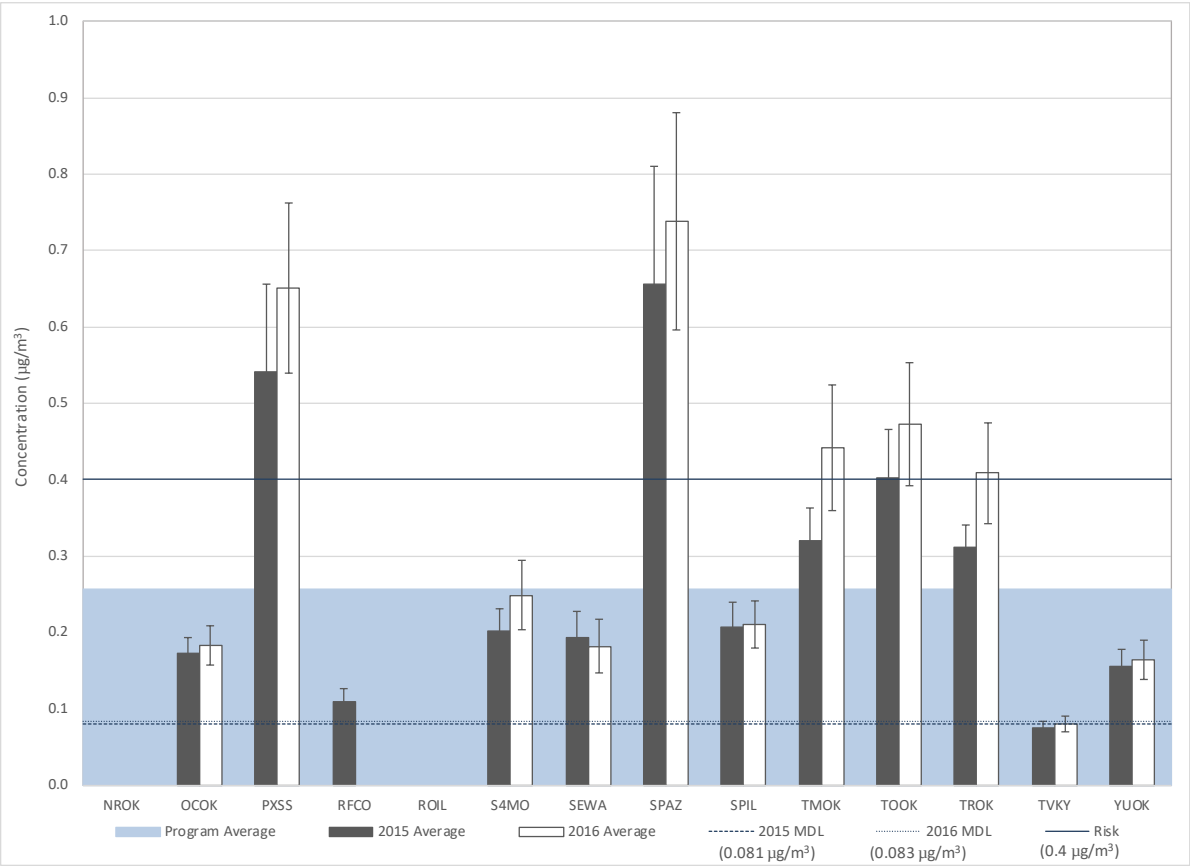
- The annual average concentrations of 1,2-dichloroethane calculated for the Calvert City, Kentucky sites are significantly higher than the annual averages for other NMP sites. Excluding the Calvert City sites, annual average concentrations of 1,2-dichloroethane range from 0.057 ± 0.004 µg/m^3 (GLKY, 2016) to 0.101 ± 0.001 µg/m^3 (TMOK, 2016). The annual average concentrations of 1,2-dichloroethane for the three Calvert City sites range from 0.41 ± 0.02 µg/m^3 (ATKY, 2015) to 3.75 ± 1.56 µg/m^3 (TVKY, 2015). The confidence intervals for these annual average concentrations are large, indicating there is considerable variability in the measurements collected at these sites. These measurements are discussed further in the Kentucky section (Section 12).

- 1,2-Dichloroethane concentrations measured at the Calvert City sites are driving the program-level average concentration (0.30 ± 0.06 µg/m^3), which was a similar finding in the 2012, 2013, 2014 NMP reports. The three Calvert City sites account for the 174 highest concentrations of 1,2-dichloroethane measured under the NMP in 2015 and 2016. Without the Calvert City sites, the program-level average concentration would be 0.08 ± <0.01 µg/m^3.

- Annual averages could not be calculated for a number of sites (and years), including BROK, BTUT, GPCO, and NRNJ for 2015; LEKY and NBNJ for 2016; and NROK and ROIL for either year. Note, however, the relocation of the NBNJ collection system to NRNJ in 2016, the initiation of sampling at BROK in 2015 and NROK in 2016, and the discontinuation of sampling at ROIL in mid-2015 and at LEKY in mid-2016.

Figure 4-9a. Inter-Site Variability for Ethylbenzene – Method TO-15





Observations from Figure 4-9a include the following:

- Figure 4-9a is the inter-site variability graph for ethylbenzene, as measured with Method TO-15. (Figure 4-9b presents the inter-site variability graph for ethylbenzene, as measured with the SNMOC method.)

- The program-level average concentration of ethylbenzene (TO-15 only) is 0.26 ± 0.01 µg/m^3, which is similar to the program-level average for 2014.

- Site-specific annual average ethylbenzene concentrations range from 0.07 ± 0.01 µg/m^3 (GLKY, 2015) to 0.74 ± 0.14 µg/m^3 (SPAZ, 2016).

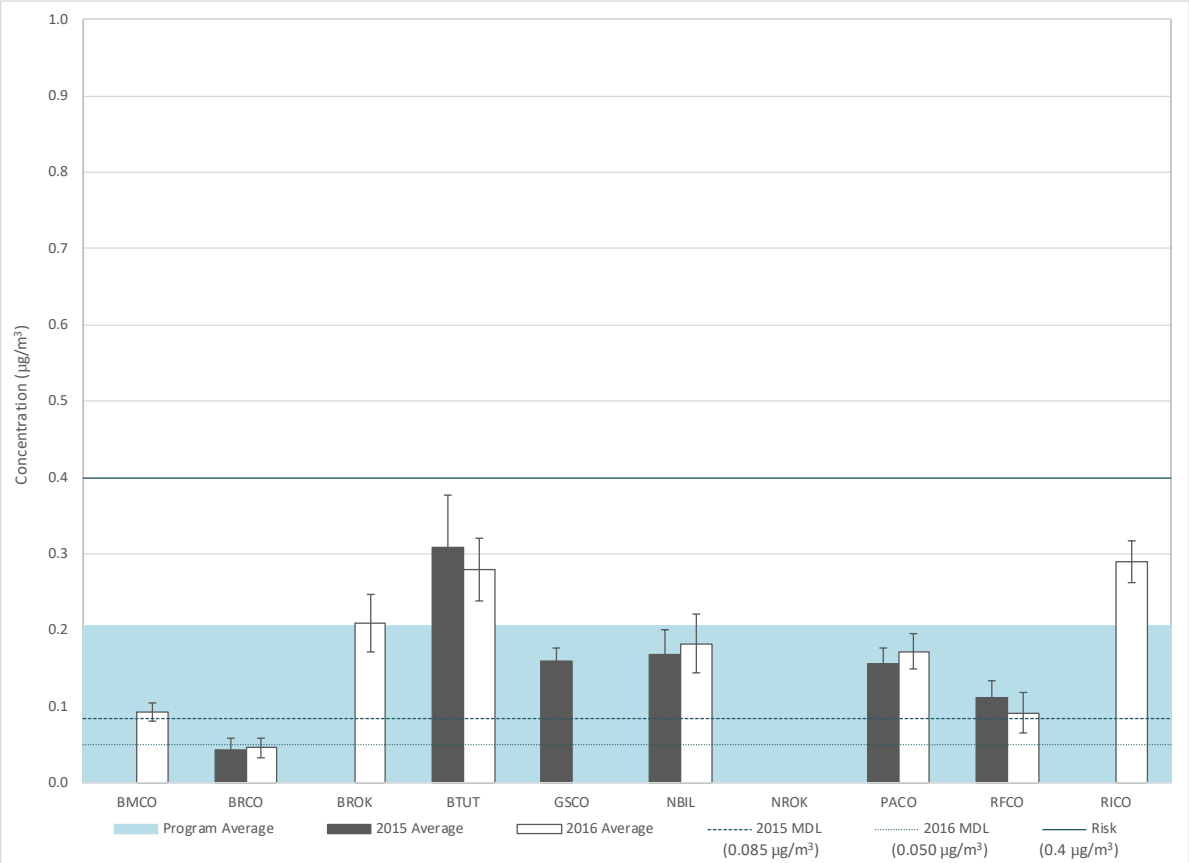
- The Phoenix, Arizona sites (PXSS, SPAZ) have annual average concentrations of ethylbenzene more than twice the program-level average concentration. Other sites measuring ethylbenzene with higher annual average concentrations (using the risk level as the cut-off) include CSNJ and the three Tulsa, Oklahoma sites. Sites with relatively low annual average concentrations of ethylbenzene (using the MDLs as a cut-off) include CHNJ and several of the Kentucky sites (GLKY, BLKY, and TVKY).

- SPAZ, PXSS, DEMI, and CSNJ have the most variability associated with the ethylbenzene measurements collected, as indicated by the relatively large confidence intervals shown in Figure 4-9a.

- Annual averages could not be calculated for a number of sites (and years), including BTUT, GPCO, and NRNJ for 2015; LEKY and NBNJ for 2016; and NROK and ROIL for either year. Note, however, the relocation of the NBNJ collection system to NRNJ in 2016, the initiation of sampling at BROK in 2015 and NROK in 2016, and the discontinuation of sampling at ROIL in mid-2015 and at LEKY in mid-2016.

- Sampling and analysis of ethylbenzene was performed with both Methods TO-15 and SNMOC for canister samples collected at RFCO between January and September 2015, after which only the SNMOC method was used. As a result, the annual average ethylbenzene concentration for RFCO with Method TO-15 is presented here, although the annual average concentration of ethylbenzene presented for this site for the remainder of the report is from the SNMOC method.

Figure 4-9b. Inter-Site Variability for Ethylbenzene – SNMOC



Observations from Figure 4-9b include the following:

- Figure 4-9b is the inter-site variability graph for ethylbenzene, as measured with the SNMOC method. Canister samples collected at 10 sites are analyzed with this method.

- The program-level average concentration of ethylbenzene (SNMOC only) is 0.21 ± 0.01 µg/m^3. Site-specific annual average concentrations of ethylbenzene (SNMOC only) range from to 0.04 ± 0.02 µg/m^3 (BRCO, 2015) to 0.31 ± 0.07 µg/m^3 (BTUT, 2015).

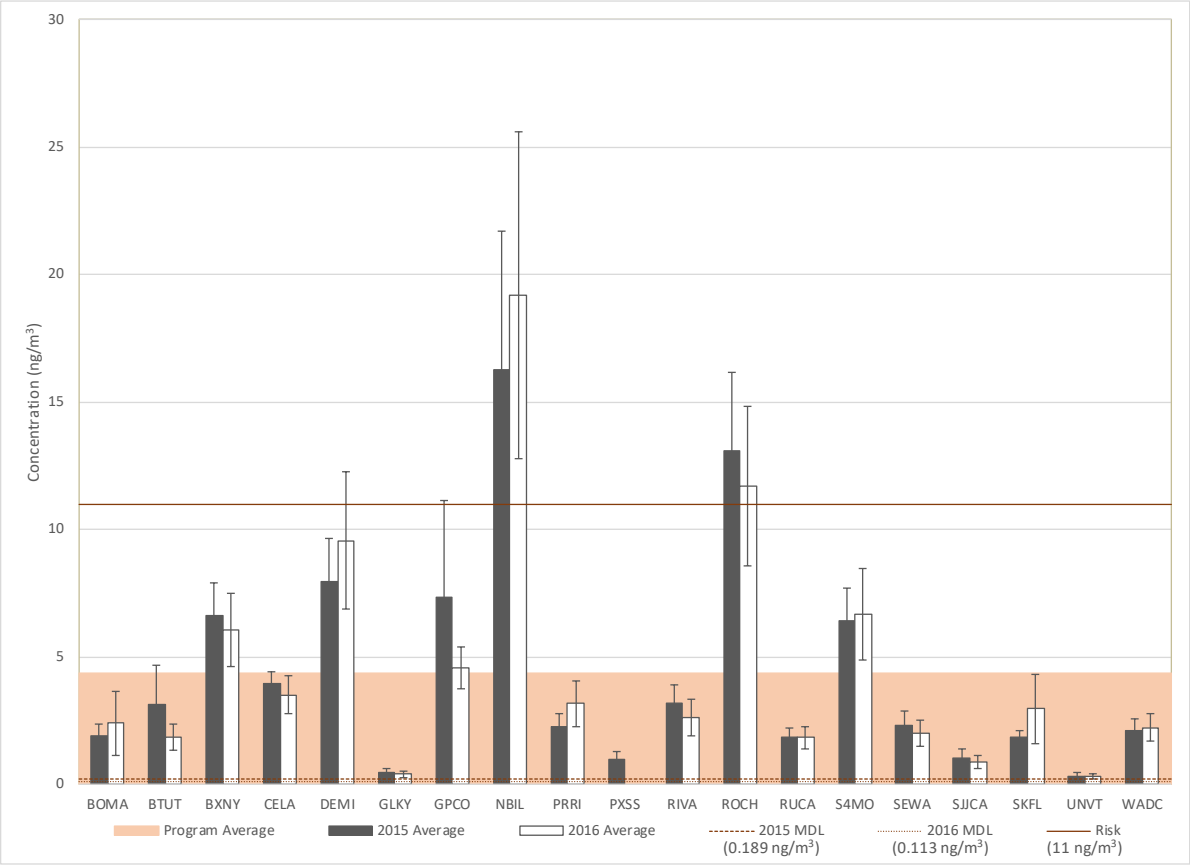
- Sites with annual average concentrations of ethylbenzene greater than the program-level average include BTUT and RICO (2016). BRCO is the only site with annual average concentrations of ethylbenzene less than 0.05 µg/m^3 (the MDL for 2016).

- A few of the sites shown in Figure 4-9b do not have annual average concentrations of ethylbenzene shown for both years. Note the initiation of sampling at BROK in 2015 and NROK in 2016, and the relocation of the BMCO collection system to GSCO in 2015 and back again in 2016. Issues related to the collection system were experienced at RICO in 2015, resulting in relatively low completeness.

- Note that canisters from BTUT and NBIL were analyzed using both methods and their annual average ethylbenzene concentrations are similar although slightly higher using the SNMOC method. The annual average concentrations of ethylbenzene presented for these two sites for the remainder of the report is from Method TO-15.

- Canisters were also analyzed with both methods for RFCO between January and September 2015. However, because the time frame of collection is different (SNMOC – all year, TO-15 – January through September 2015 only), the averages shown should not be compared directly. The annual average concentration of ethylbenzene presented for this site for the remainder of the report is from the SNMOC method.

Figure 4-10. Inter-Site Variability for Fluorene



Observations from Figure 4-10 include the following:

- Figure 4-10 presents the program-level and site-specific annual average concentrations of fluorene.

- The program-level average concentration of fluorene is 4.36 ± 0.35 ng/m^3, as shown in orange in Figure 4-10.

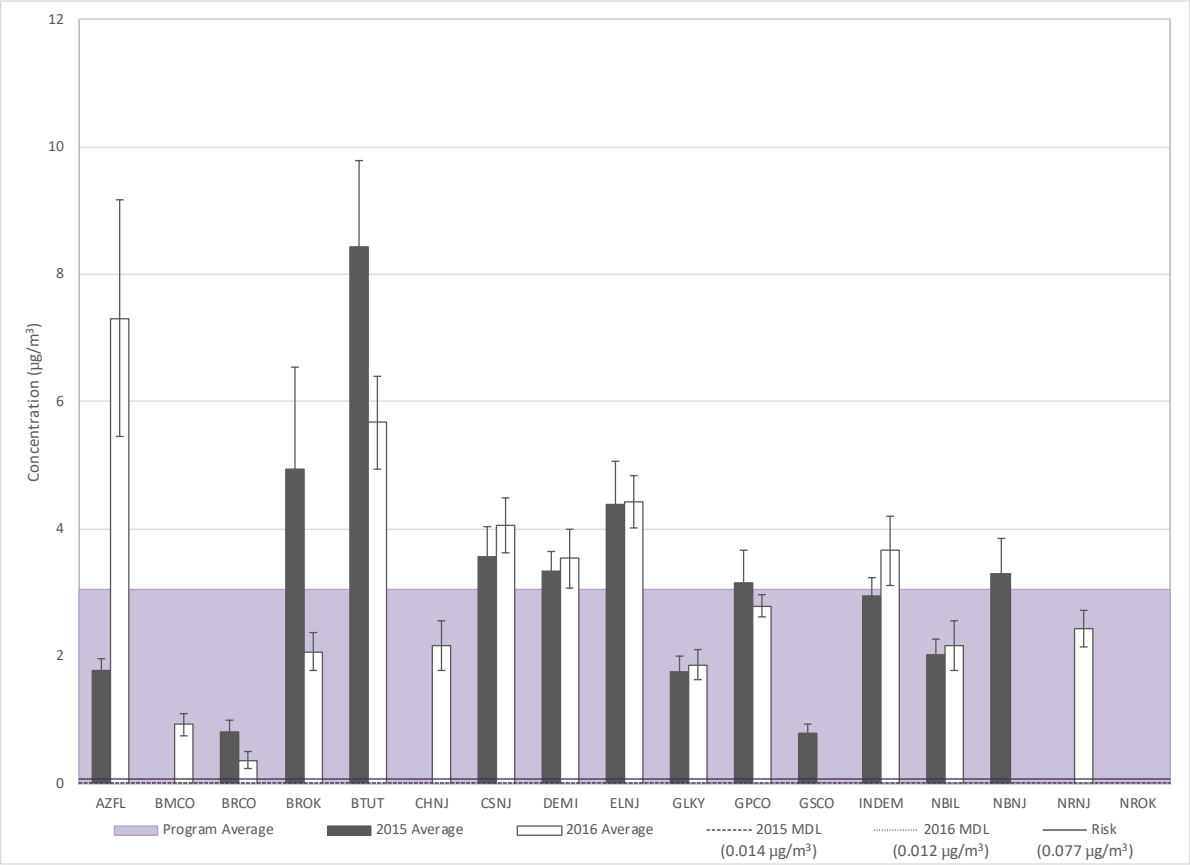
- Site-specific annual average concentrations range from 0.30 ± 0.10 ng/m^3 (UNVT, 2016) to 19.19 ± 6.42 ng/m^3 (NBIL, 2016).

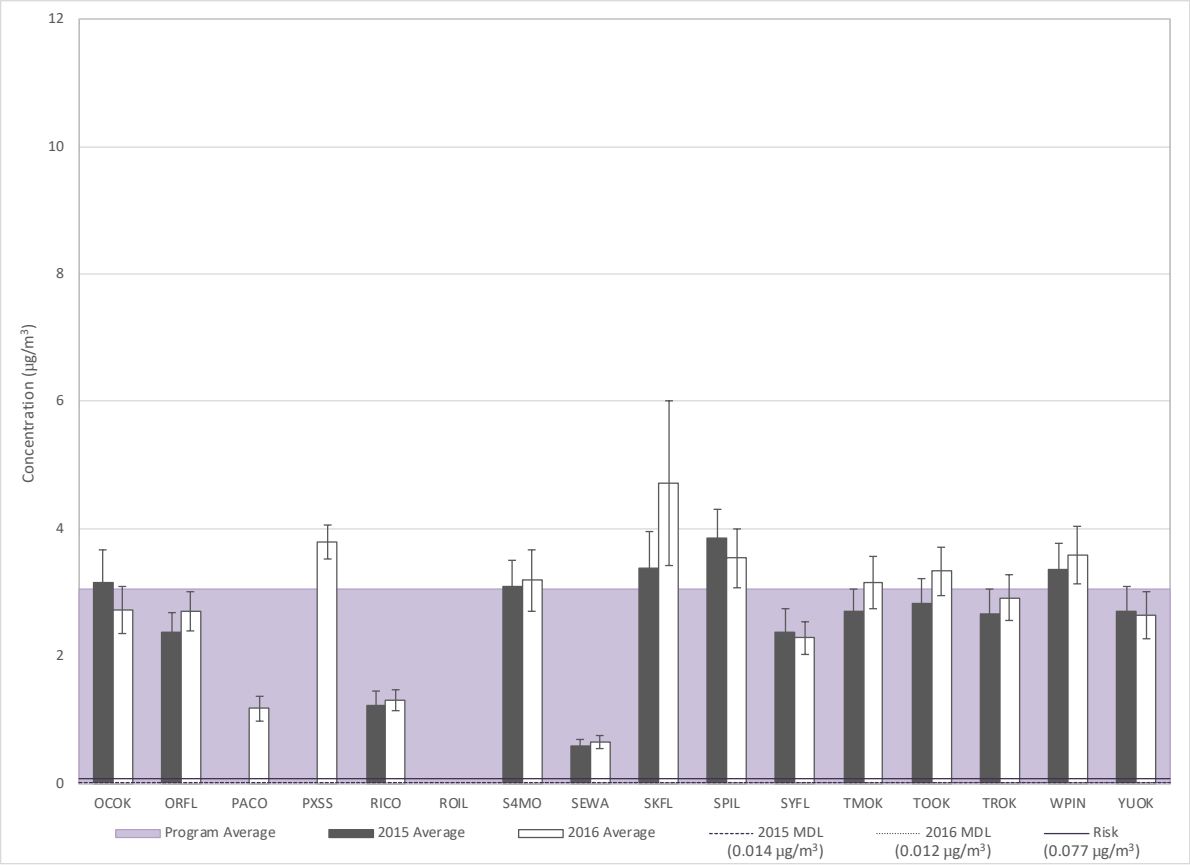
- Both annual average concentrations of fluorene for NBIL are more than four times greater than the program-level average concentration for fluorene. ROCH's annual average concentrations are more than two (2016) and three (2015) times greater than the program-level average. Other sites with annual average concentrations greater than the program-level average include BXNY, DEMI, GPCO, and S4MO.

- Sites with relatively low annual average concentrations of fluorene (less than 1 ng/m^3) include UNVT, GLKY, SJJCA, and PXSS.

- An annual average concentration could not be calculated for PXSS for 2016 due to issues with the collection system resulting in relatively low completeness.

Figure 4-11. Inter-Site Variability for Formaldehyde





Observations from Figure 4-11 include the following:

- Figure 4-11 presents the program-level and site-specific annual average concentrations of formaldehyde.

- The program-level average concentration of formaldehyde is 3.05 ± 0.09 µg/m^3, as shown in purple in Figure 4-11.

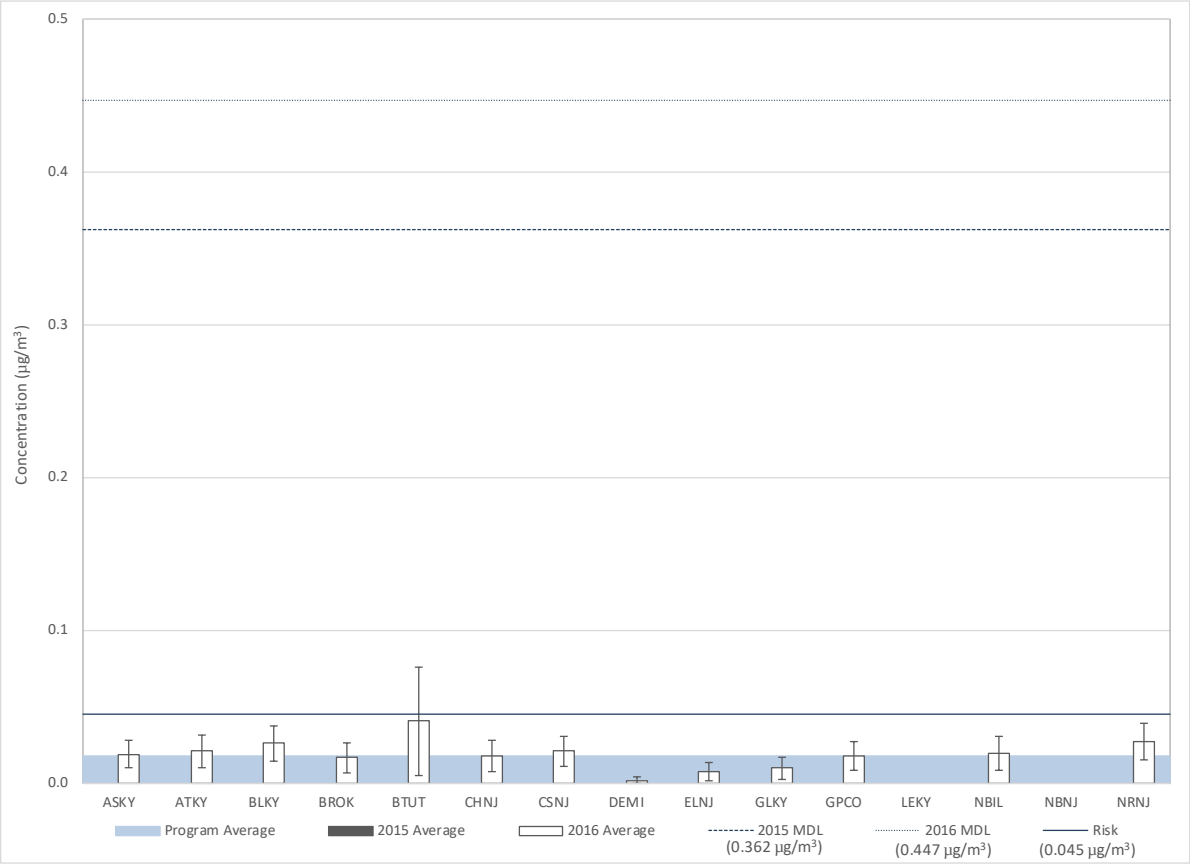
- Site-specific annual average concentrations range from 0.37 ± 0.14 µg/m^3 (BRCO, 2016) to 8.42 ± 1.37 µg/m^3 (BTUT, 2015). 2015 is the fifth year in a row (2011-2015) that BTUT has had the highest annual average concentration of formaldehyde among NMP sites.

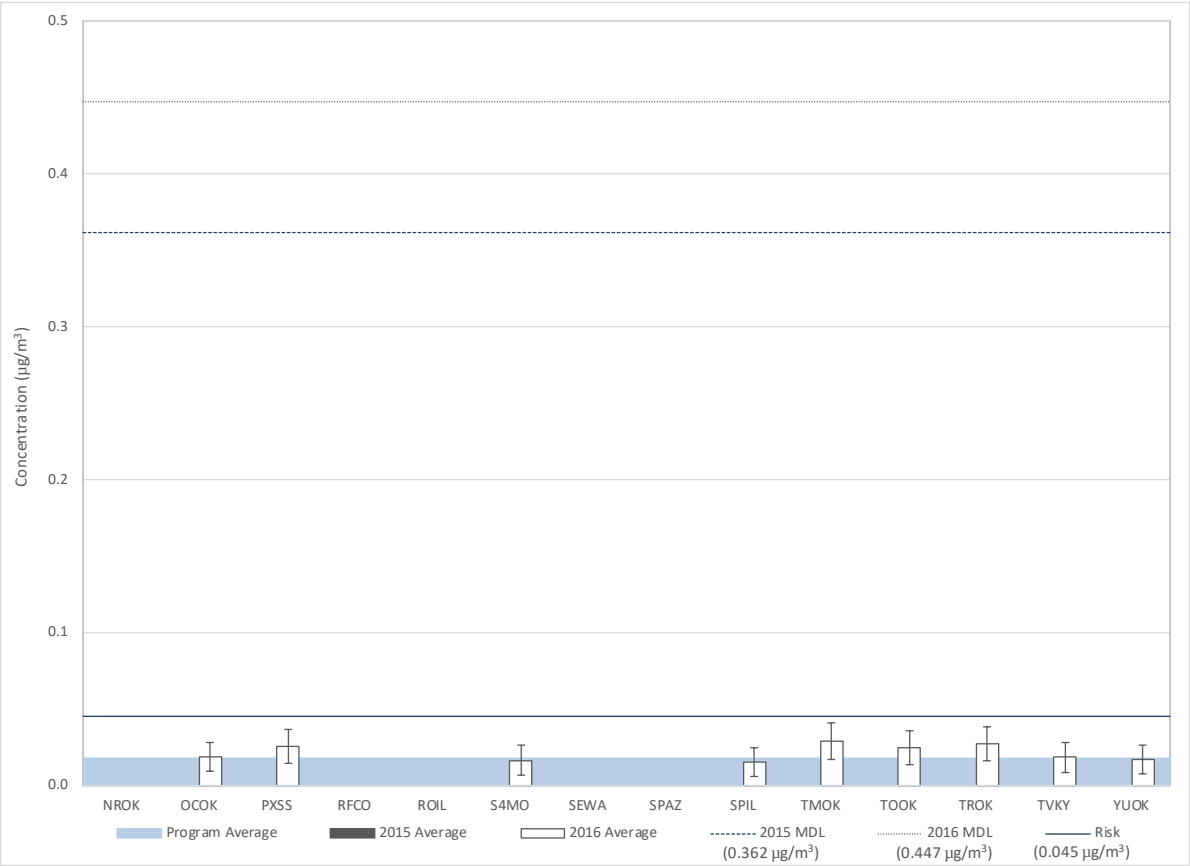
- Although nearly 2 µg/m^3 separates BTUT's 2015 (8.42 ± 1.37 µg/m^3) and 2016 (5.68 ± 0.72 µg/m^3) annual average concentrations of formaldehyde, this site has the highest and third highest annual averages among NMP sites sampling this pollutant. Only AZFL also has an annual average concentration greater than 5 µg/m^3 (2016, 7.31 ± 1.85 µg/m^3). The 2016 annual average concentration of formaldehyde for AZFL is more than four times this site's 2015 annual average concentration (1.79 ± 0.18 µg/m^3). Other sites besides AZFL and BTUT exhibiting this disparity between their two annual averages include BROK and, to a lesser extent, SKFL.

- Sites with relatively low annual average concentrations of formaldehyde (less than 1 µg/m^3) include BMCO (2016), BRCO, GSCO (2015), and SEWA.

- Annual averages could not be calculated for a number of sites (and years), including BMCO, CHNJ, NRNJ, PACO, PXSS, and RICO for 2015; GSCO and NBNJ for 2016; and NROK and ROIL for either year. Note, however, the relocation of the NBNJ collection system at NRNJ in 2016, the relocation of the BMCO collection system at GSCO in 2015 and back again in 2016, the initiation of sampling at NROK in 2016, and the discontinuation of sampling at ROIL in mid-2015.

Figure 4-12. Inter-Site Variability for Hexachloro-1,3-butadiene





Observations from Figure 4-12 include the following:

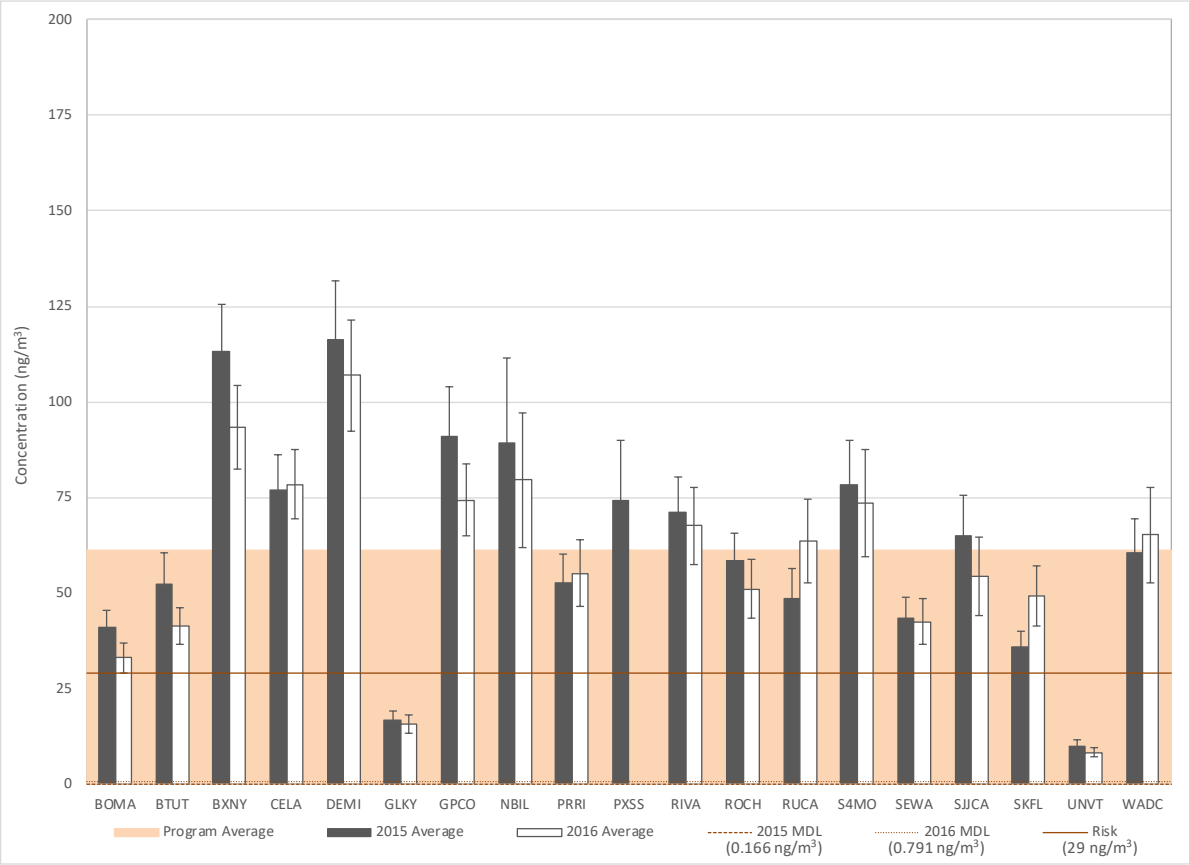
- Figure 4-12 presents the program-level and annual average concentrations of hexachloro-1,3-butadiene. Annual average concentrations of hexachloro-1,3-butadiene for 2015 could not be calculated due to a standard contamination issue that resulted in the invalidation of a large portion of the 2015 data for this pollutant.

- The program-level average concentration (0.017 ± 0.002 µg/m^3) and all the site-specific annual average concentrations shown are considerably less than the MDLs for this pollutant, despite the difference between them (0.362 µg/m^3 for 2015 and 0.447 µg/m^3 for 2016), as indicated by the dashed blue lines. This indicates that many of the measurements are either non-detects or less than the detection limits. Table 4-1 shows that 80 percent of the measurements of hexachloro-1,3-butadiene were non-detects and that only one of the measured detections was greater than the MDL. This concentration was measured at BTUT on January 7, 2016 (1.02 µg/m^3) and is more than six times greater than the next highest hexachloro-1,3-butadiene concentration measured across the two years of sampling. The effects of this outlier can be seen in the relatively large confidence interval associated with BTUT's 2016 annual average hexachloro-1,3-butadiene concentration.

- Site-specific annual average concentrations range from 0 µg/m^3 for SEWA and SPAZ for 2016 (indicating that this pollutant was not detected at these sites in 2016) to 0.041 ± 0.035 µg/m^3 (BTUT, 2016). Over the two years of sampling, the number of measured detections varied from 23 (BLKY) to none (RFCO, SEWA, and SPAZ).

- Annual averages could not be calculated for a number of sites (and years), including BROK, BTUT, GPCO, and NRNJ for 2015; LEKY and NBNJ for 2016; and NROK and ROIL for either year. Note, however, the relocation of the NBNJ collection system to NRNJ in 2016, the initiation of sampling at BROK in 2015 and NROK in 2016, and the discontinuation of sampling at ROIL in mid-2015 and at LEKY in mid-2016.

Figure 4-13. Inter-Site Variability for Naphthalene



Observations from Figure 4-13 include the following:

- Figure 4-13 presents the program-level and site-specific annual average concentrations of naphthalene.

- The program-level average concentration of naphthalene is 61.23 ± 1.96 ng/m^3, as shown in orange in Figure 4-13.

- Site-specific annual average concentrations range from 8.39 ± 1.17 ng/m^3 (UNVT, 2016) to 116.18 ± 15.46 ng/m^3 (DEMI, 2015). Aside from DEMI, the only other site with an annual average concentration greater than 100 ng/m^3 is BXNY (113.05 ± 12.40 ng/m^3, 2015). Sites with annual average concentrations less than 29 ng/m^3 (the risk level shown in Figure 4-13) are UNVT and GLKY.

- The site with the most variability in the measurements, as indicated by the magnitude of the confidence intervals, is NBIL. Concentrations measured at NBIL span three orders of magnitude, ranging from 0.446 ng/m^3 (the minimum naphthalene concentration measured across the program) to 403 ng/m^3.

- An annual average concentration could not be calculated for PXSS for 2016 due to issues with the collection system resulting in relatively low completeness.

4.2.2.2 Quarterly Variability Analysis

Figures 4-14 through 4-26 provide a graphical display of the site-specific quarterly average concentrations for each of the program-level pollutants of interest. Quarterly average concentrations are calculated based on the criteria specified in Section 3.1. For each metal pollutant of interest, there are two graphs, one for PM_{10} and one for TSP, the scales for which are the same.

The design of these figures changed for the 2015-2016 NMP report, from a two-dimensional version to a three-dimensional version. The benefits of this change are two-fold: 1) the latest version allows for the plotting of multiple years of data on a fairly easy-to-view graph, and 2) quarterly average concentrations of zero (resulting from the substitution of zeros for non-detects) can be easily identified in the graphs (in the 2-D version, they appeared to be "missing"). In addition, quarterly average benzene concentrations for sites whose canisters are analyzed using different methods (i.e., Method TO-15 and SNMOC) are provided on the same graph, such that they match the quarterly average concentrations provided in the individual state sections. This is also true for 1,3-butadiene and ethylbenzene. The MDLs and risk factors presented in the previous section were not added to the quarterly variability graphs for this report, so not the convolute the graphs.

"Missing" quarterly average concentrations in the figures can be attributed to several reasons. One reason for missing quarterly averages is due to the sampling duration of each site. Some sites started late or ended early in the year, which may result in a lack of quarterly averages. Additionally, the criteria specified in Section 3.1 require a site to have 75 percent of the possible samples within a given calendar quarter (12 for a site sampling on a 1-in-6 day schedule) for a quarterly average concentration to be calculated. A quarterly average concentration is not presented for sites that did not meet this criterion. Co-elution can also affect whether a site has a quarterly average concentration for different pollutants measured and analyzed by different methods.

Comparing the quarterly average concentrations may provide insight on the detection rate of the pollutants of interest. Comparing quarterly average concentrations for sites with four valid quarterly averages in a given year may reveal a temporal trend for some pollutants, such as formaldehyde, the quarterly averages for which tend to be highest for the summer months, based on this and previous reports. Trends in quarterly average concentrations are discussed below and in more detail in the state sections (Sections 5 through 23). The quarterly average concentration

comparison also allows for the identification of sites with unusually high concentrations of the pollutants of interest compared to other sites and when those high concentrations were measured; if concentrations measured at a specific site are significantly lower than other sites; when there is little variability in the quarterly averages across other sites; and whether inter-state trends exist.

Figure 4-14. Comparison of Quarterly Average Acenaphthene Concentrations

Observations from Figure 4-14 include the following:

- Figure 4-14 presents the site-specific quarterly average concentrations of acenaphthene.

- Quarterly average concentrations of acenaphthene range from 0 ng/m^3 (GLKY and UNVT, first quarter 2015) to 46.29 ± 11.43 ng/m^3 (NBIL, third quarter 2016).

- The highest quarterly average concentrations for acenaphthene for many of the sites were calculated for the second and third quarters of each year (during the warmer months of the years), as indicated by the yellow and blue bars in Figure 4-14.

- NBIL and ROCH have the highest quarterly average concentrations of acenaphthene; the third quarter averages for both sites for both years are greater than 30 ng/m^3. These sites' second quarter averages are also among the highest calculated. Other sites with quarterly average concentrations of acenaphthene greater than 10 ng/m^3 include DEMI, GPCO, and S4MO, all of which were calculated for either the second or third quarter of a given year.

Figure 4-15. Comparison of Quarterly Average Acetaldehyde Concentrations

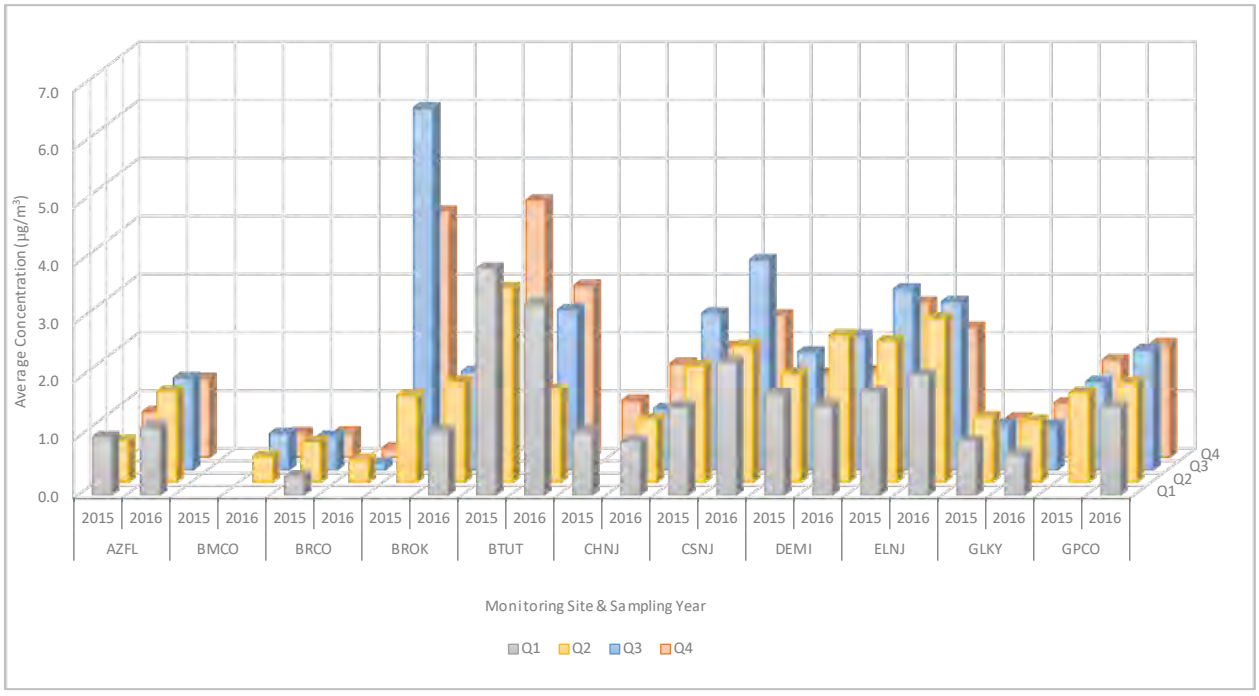
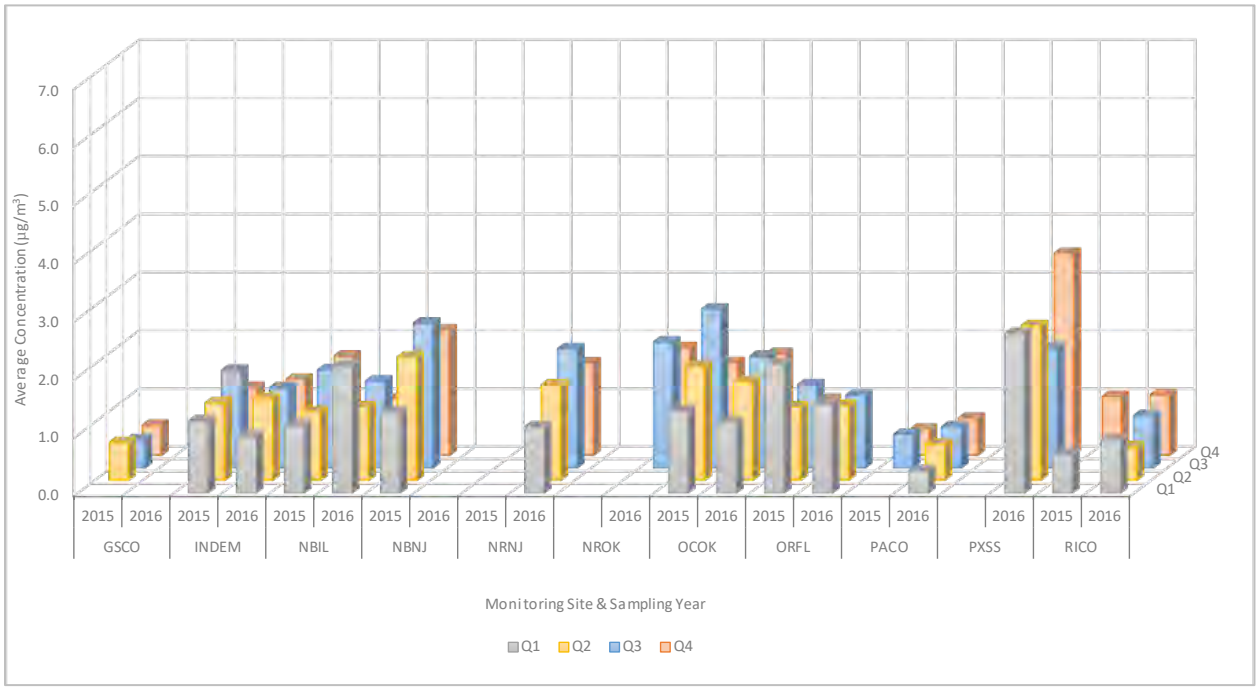
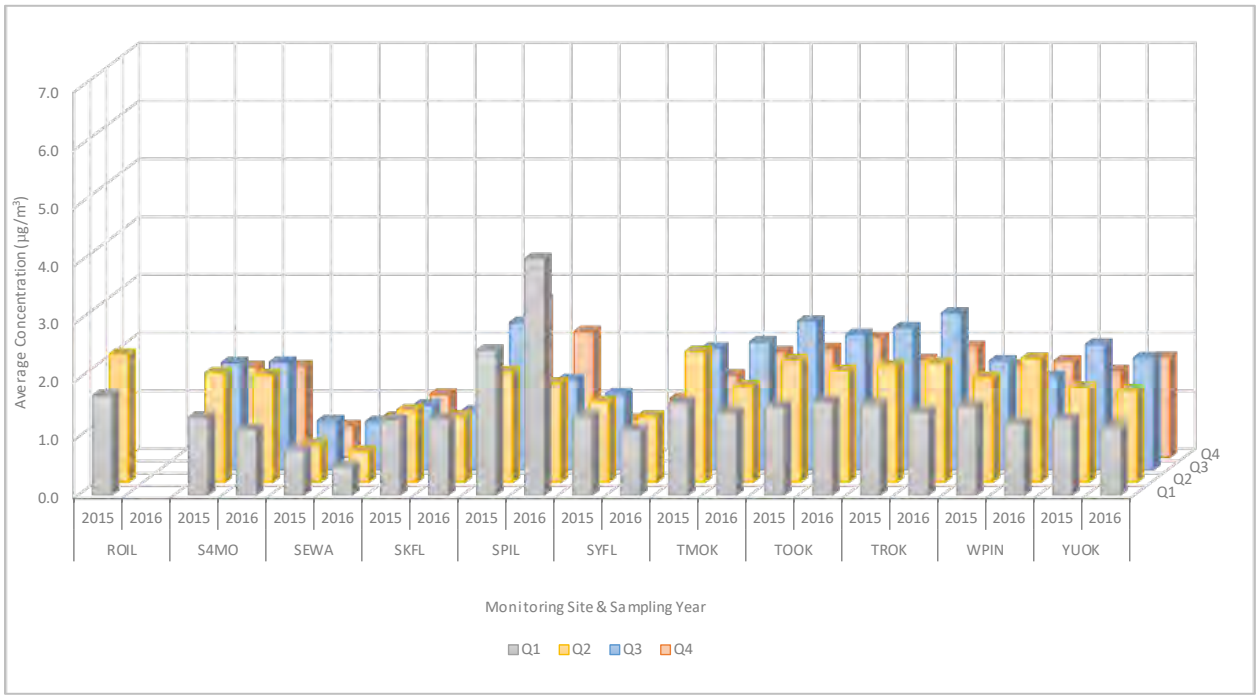


Figure 4-15. Comparison of Quarterly Average Acetaldehyde Concentrations (Continued)





Observations from Figure 4-15 include the following:

- Figure 4-15 presents the site-specific quarterly average concentrations of acetaldehyde.

- Quarterly average concentrations of acetaldehyde range from 0.11 ± 0.06 µg/m^3 (BRCO, third quarter 2016) to 6.23 ± 3.78 µg/m^3 (BROK, third quarter 2015), which are plotted side-by-side in Figure 4-15.

- This figure shows which sites have consistently higher quarterly average concentrations (e.g., BTUT), consistently lower quarterly average concentration (e.g., GLKY), or where concentrations exhibited considerable variability among the calendar quarters (e.g., BROK). BROK's quarterly average concentrations exhibit the most variability among the sites, particularly for 2015, varying by more than 5 µg/m^3. Other sites besides BROK who's quarterly average concentrations of acetaldehyde vary by more than 2 µg/m^3 include BTUT, CSNJ, and SPIL. Conversely, sites who's quarterly average concentrations of acetaldehyde vary by less than 0.5 µg/m^3 include GLKY, GSCO, BMCO, NROK, PACO, RICO, SEWA, and SKFL.

- Among the sites sampling this pollutant that have four quarterly average concentrations available for a given year (45 site-year combinations), the third quarter average concentrations were most often higher than the other quarterly averages (24 in total, 13 for 2016 and 11 for 2015). These can be seen by the blue bars extending higher in Figure 4-15 than the others; examples include CSNJ, ELNJ, OCOK, TOOK, TROK, and YUOK.

Figure 4-16a. Comparison of Quarterly Average PM_{10} Arsenic Concentrations

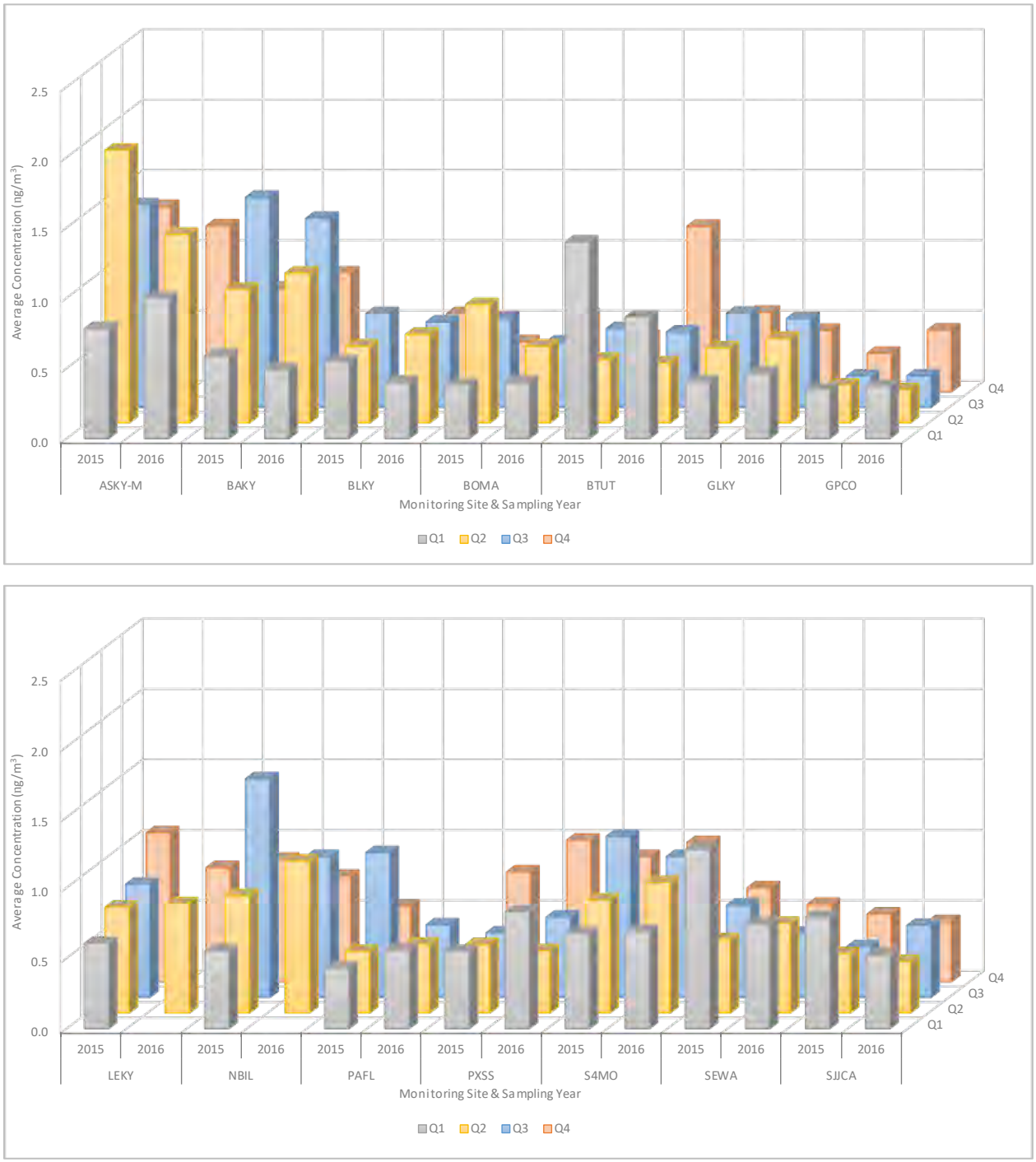
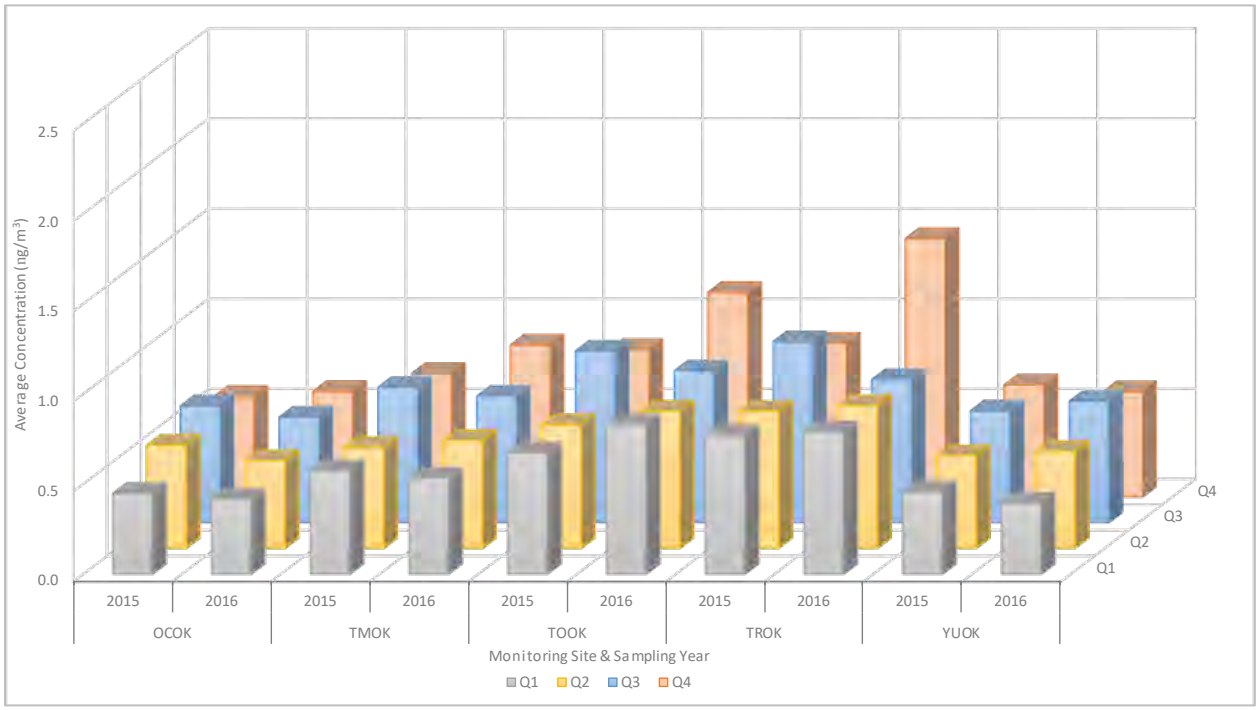


Figure 4-16b. Comparison of Quarterly Average TSP Arsenic Concentrations



Observations from Figures 4-16a and 4-16b include the following:

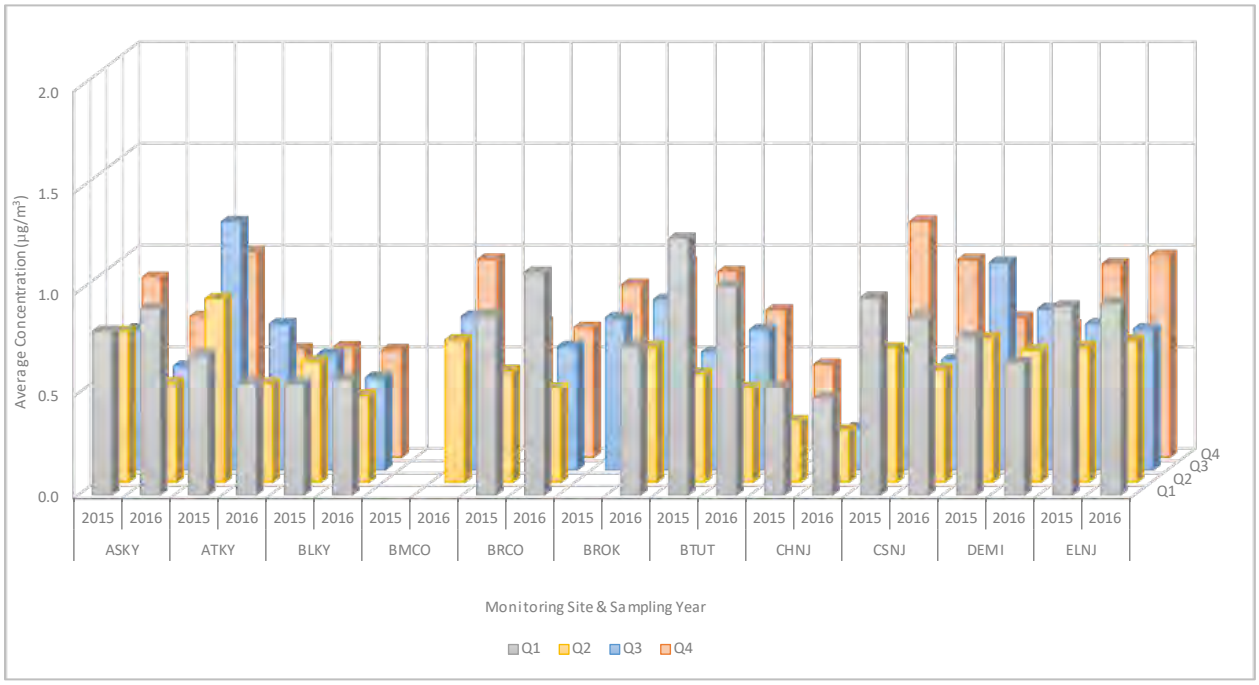
- Figures 4-16a and 4-16b present the quarterly average concentrations of arsenic for sites sampling speciated metals, first for PM_{10} then for TSP.

- These figures show that the quarterly average concentrations of arsenic vary more for those sampling the PM_{10} fraction compared to TSP fraction. This is not altogether unexpected, given that the sampling locations are more varied among the PM_{10} sites (the five TSP sites are located in either Tulsa or Oklahoma City, Oklahoma).

- Quarterly average concentrations of arsenic range from 0.22 ± 0.04 ng/m^3 (GPCO, third quarter 2015) to 1.94 ± 0.96 ng/m^3 (ASKY-M, second quarter 2015). ASKY-M and NBIL are the only sites for which a quarterly average concentration of arsenic greater than 1.5 ng/m^3 was calculated (1.94 ± 0.96 ng/m^3, second quarter 2015 for ASKY-M and 1.55 ± 1.08 ng/m^3, third quarter 2015 for NBIL).

- This figure shows which sites have consistently higher quarterly average concentrations (e.g., ASKY-M), consistently lower quarterly average concentrations (e.g., GPCO), or where concentrations exhibited considerable variability among the calendar quarters (e.g., BTUT). ASKY-M not only has some of the highest quarterly averages, but this site's quarterly average concentrations exhibit the most variability among the sites, particularly for 2015. Other sites besides ASKY-M who's quarterly average concentrations of arsenic vary by more than 1 ng/m^3 include BTUT, BAKY, and NBIL. Conversely, sites who's quarterly average concentrations of arsenic vary by less than 0.30 ng/m^3 include BLKY, GLKY, GPCO, OCOK, and YUOK.

Figure 4-17. Comparison of Quarterly Average Benzene Concentrations



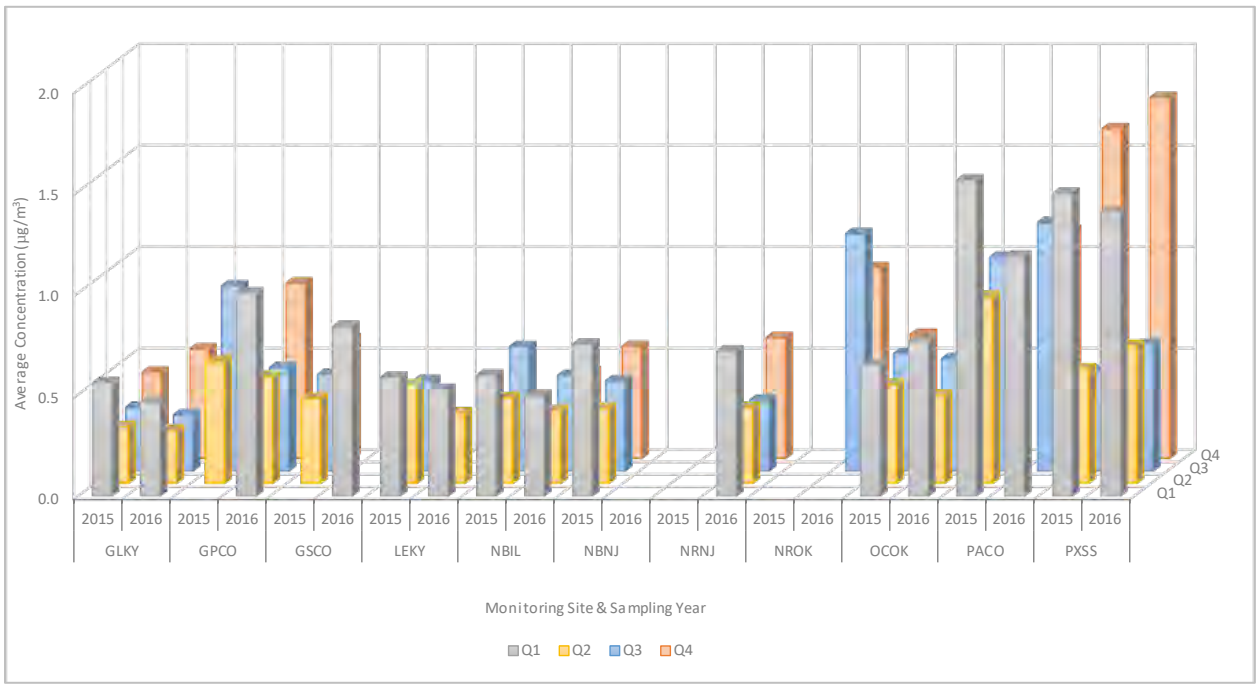
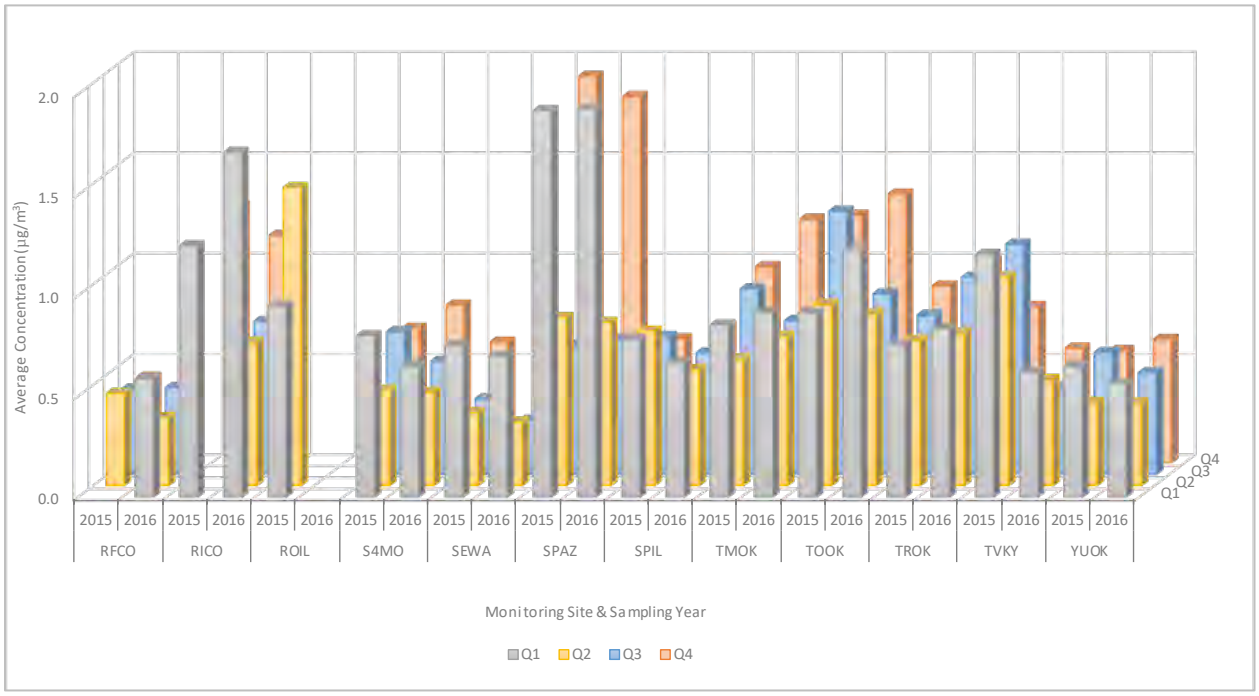


Figure 4-17. Comparison of Quarterly Average Benzene Concentrations (Continued)



Observations from Figure 4-17 include the following:

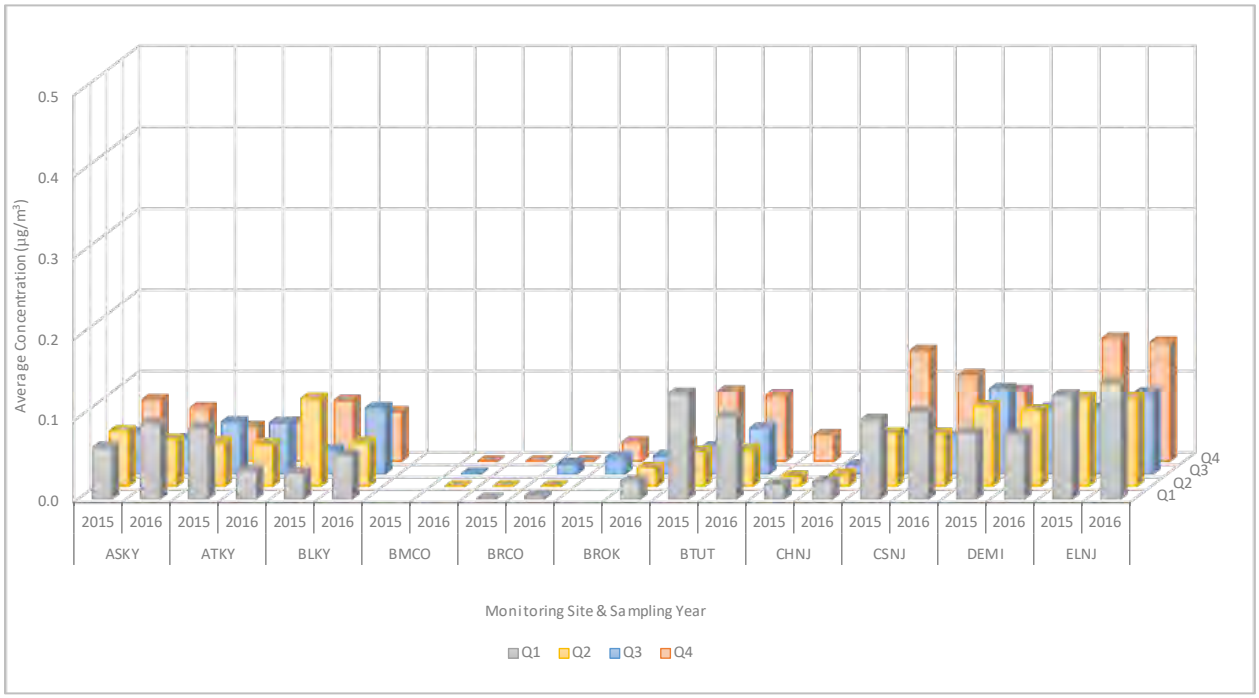
- Figure 4-17 presents the site-specific quarterly average concentrations of benzene.

- Quarterly average concentrations of benzene range from 0.21 ± 0.03 µg/m^3 (CHNJ, third quarter 2016) to 1.93 ± 0.74 µg/m^3 (SPAZ, first quarter 2016, with similar averages for the first and fourth quarters of 2015).

- This figure shows which sites have consistently higher quarterly average concentrations (e.g., SPAZ), consistently lower quarterly average concentration (e.g., RFCO), or where concentrations exhibited considerable variability among the quarters (e.g., PXSS, RICO). The quarterly average concentrations for PXSS and SPAZ exhibit the most variability among the sites sampling benzene. For both sites, the first and fourth quarter average concentrations were considerably higher than the second and third quarter averages. This is true for both years. RICO is the only other site besides PXSS and SPAZ who's quarterly average concentrations of benzene vary by more than 1 µg/m^3. Conversely, sites who's quarterly average concentrations of benzene vary by less than 0.25 µg/m^3 include BLKY, LEKY, RFCO, SPIL, and YUOK.

- Among the sites sampling this pollutant that have four quarterly average concentrations available for a given year (46 site-year combinations), the first and fourth quarter average concentrations tended to be higher than the other quarterly averages (40 in total, 22 for the first quarter and 18 for the fourth quarter). These can be seen by the gray and orange bars extending higher in Figure 4-17 than the others; examples in the figure where this can readily be seen include ELNJ, NBNJ, NRNJ, PXSS, and SPAZ.

Figure 4-18. Comparison of Quarterly Average 1,3-Butadiene Concentrations



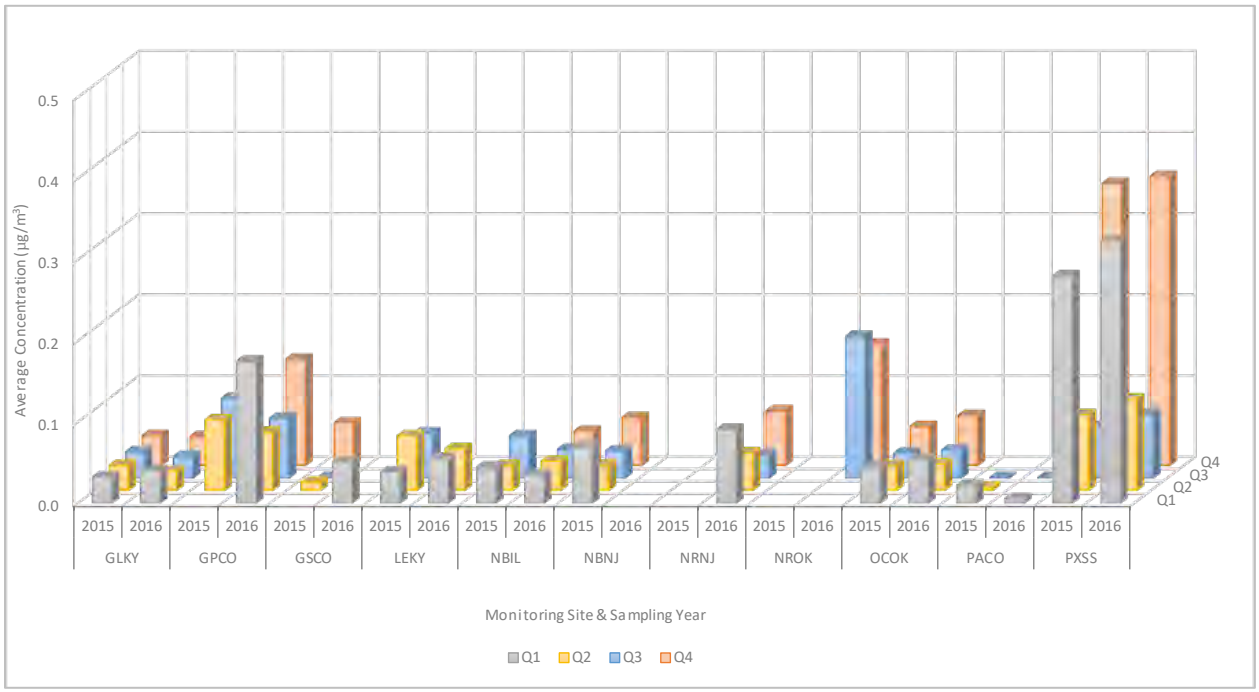
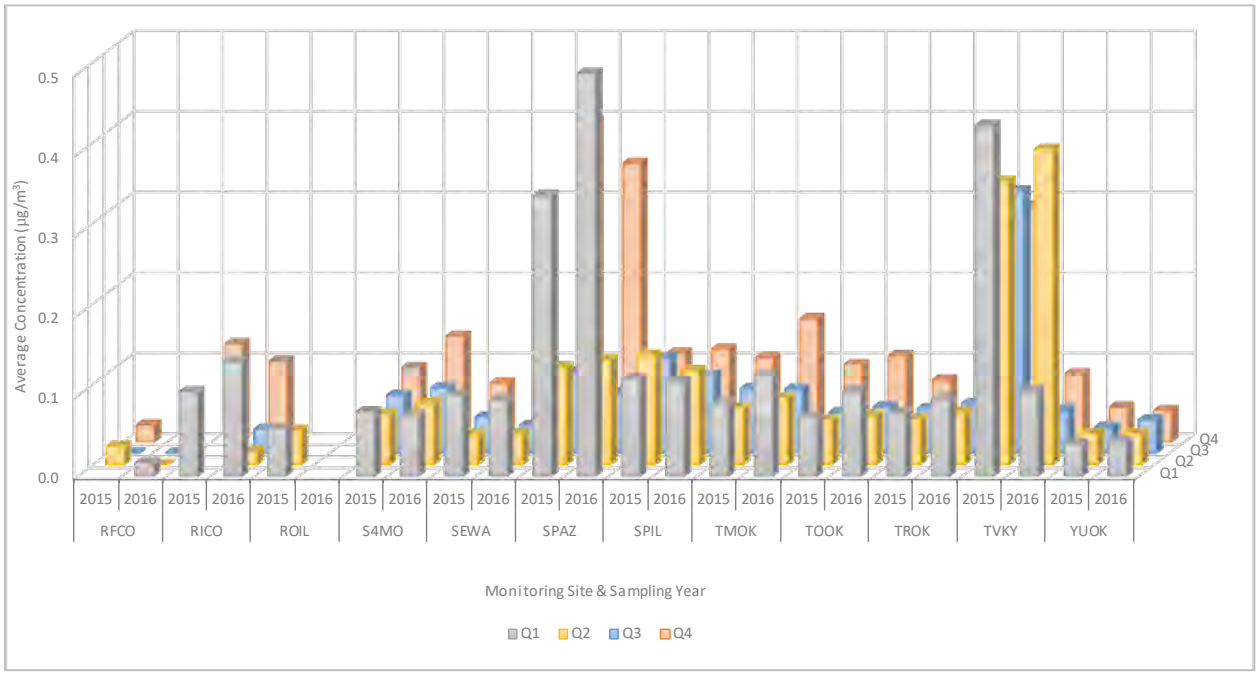


Figure 4-18. Comparison of Quarterly Average 1,3-Butadiene Concentrations (Continued)



Observations from Figure 4-18 include the following:

- Figure 4-18 presents the quarterly average concentrations for sites sampling 1,3-butadiene.

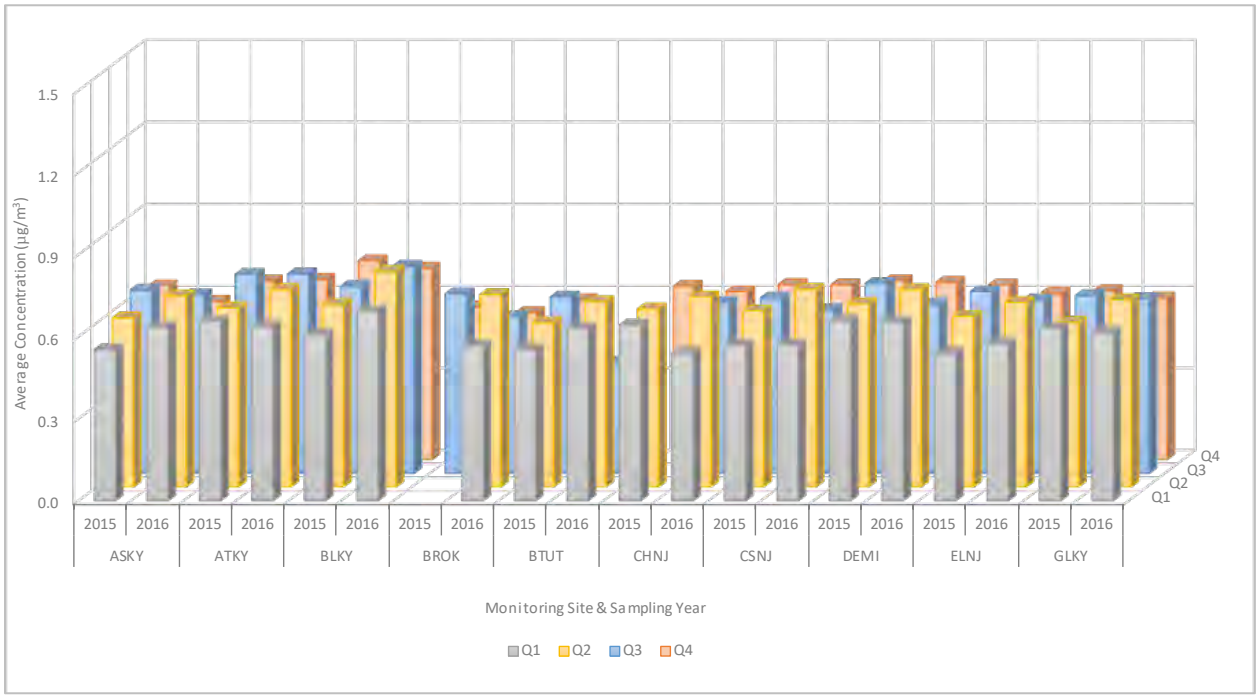
- Quarterly average concentrations of 1,3-butadiene range from 0 µg/m^3 (several sites and several quarters) to 0.52 ± 0.29 µg/m^3 (SPAZ, first quarter 2016). Other sites with relatively high quarterly average concentrations of 1,3-butadiene include PXSS and TVKY.

- For sites sampling this pollutant with only the SNMOC method, the quarterly average concentrations shown are very low, often appearing at or close to zero; sites sampling 1,3-butadiene exclusively with the SNMOC method include most of the Garfield County, Colorado sites (BMCO, BRCO, GSCO, PACO, and RICO). The detection rate of 1,3-butadiene with the SNMOC method is generally lower than the detection rate for Method TO-15. Note the 1,3-butadiene was not detected at BMCO in 2015 (January and February only) or 2016 (February through December); 1,3-butadiene was not detected at BRCO in 2015 and was detected only twice at this site in 2016.

- This figure shows which sites have consistently higher quarterly average concentrations (e.g., TVKY), consistently lower quarterly average concentration (e.g., Garfield County, Colorado, GLKY, YUOK), or where concentrations exhibited considerable variability among the quarters (e.g., PXSS, SPAZ). The quarterly average concentrations for PXSS, SPAZ, and TVKY exhibit the most variability among the sites sampling 1,3-butadiene. Conversely, sites who's quarterly average concentrations of benzene vary by less than 0.025 µg/m^3 include BRCO, BROK, GLKY, and YUOK.

- Among the sites sampling this pollutant that have four quarterly average concentrations available for a given year (46 site-year combinations), the first and fourth quarter average concentrations were often higher than the other quarterly averages (38 in total, 17 for the first quarter and 21 for the fourth quarter). These can be seen by the gray and orange bars extending higher in Figure 4-18 than the others; examples in the figure where this can readily be seen include BTUT, ELNJ, PXSS, SPAZ, and TMOK.

Figure 4-19. Comparison of Quarterly Average Carbon Tetrachloride Concentrations



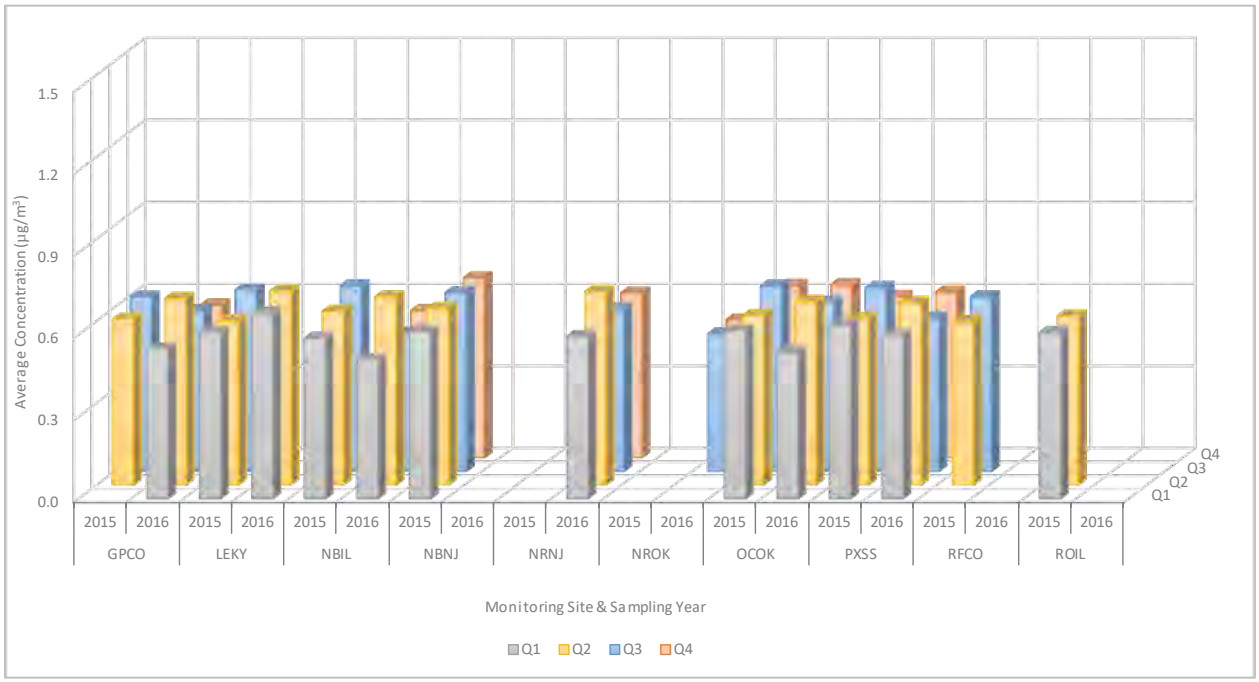
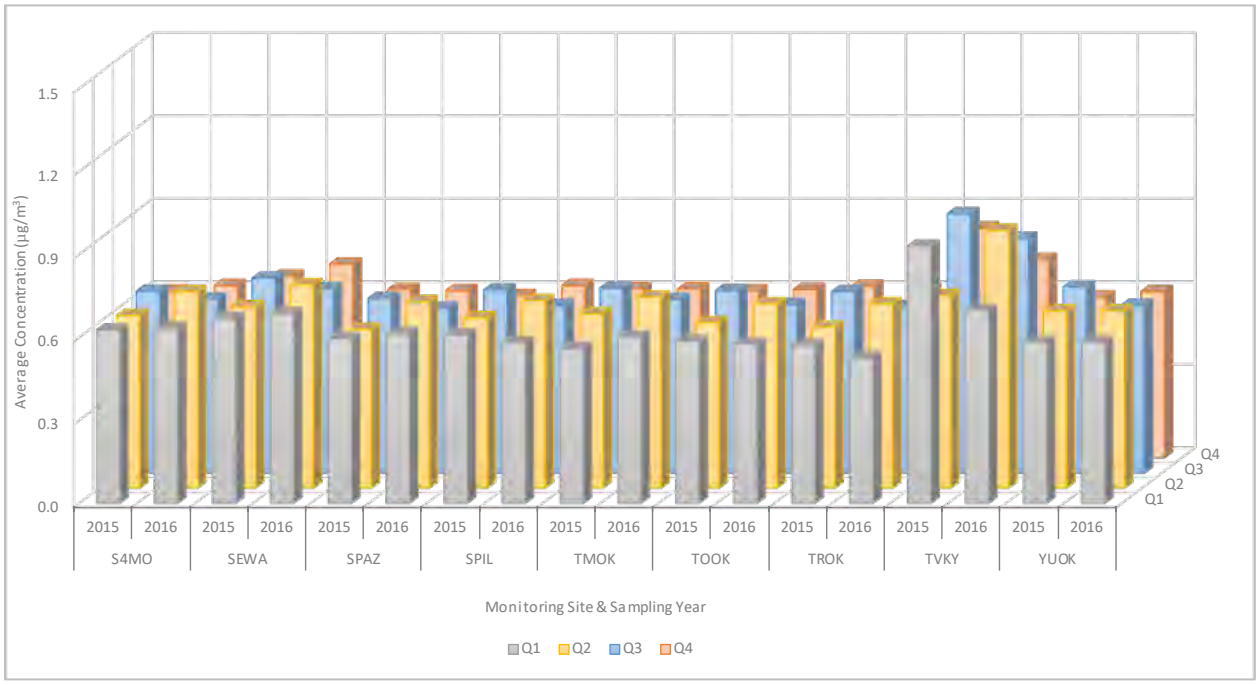


Figure 4-19. Comparison of Quarterly Average Carbon Tetrachloride Concentrations (Continued)



Observations from Figure 4-19 include the following:

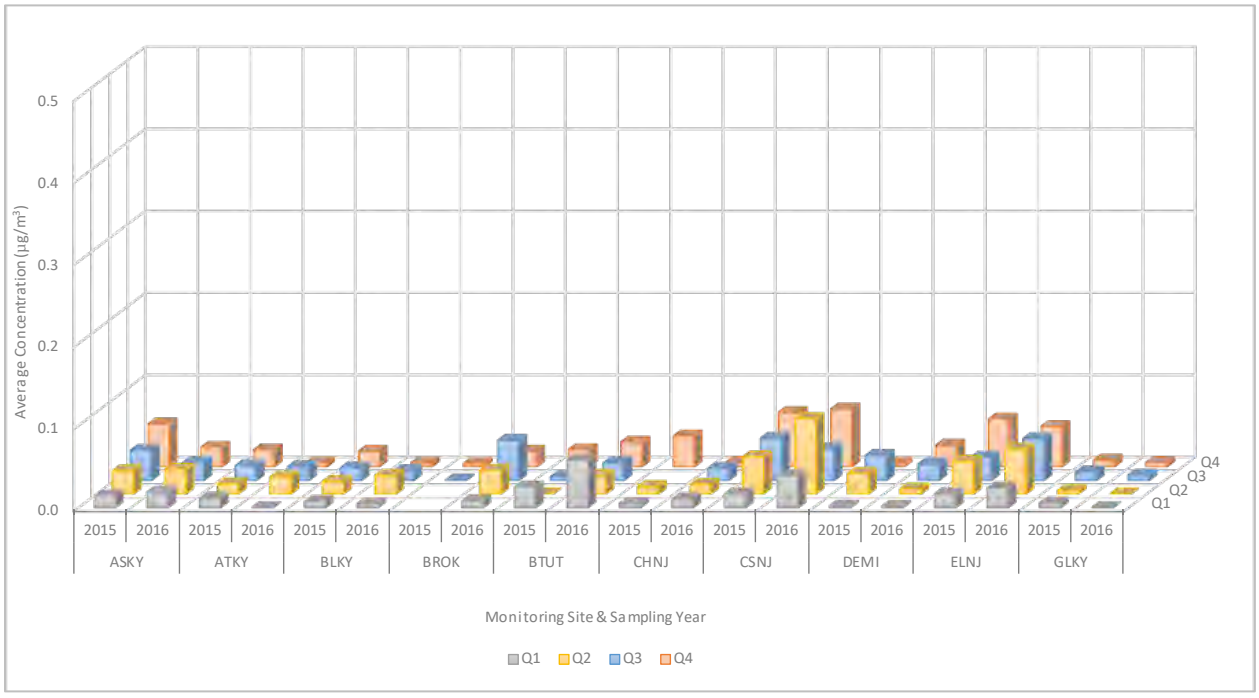
- Figure 4-19 presents the site-specific quarterly average concentrations of carbon tetrachloride.

- Quarterly average concentrations of carbon tetrachloride range from 0.40 ± 0.11 µg/m^3 (BTUT, third quarter 2016) to 0.94 ± 0.42 µg/m^3 (TVKY, third quarter 2015, with similar averages for the first quarter of 2015 and second quarter 2016).

- Figure 4-19 shows that the quarterly average concentrations of carbon tetrachloride for most monitoring sites vary by less than 0.25 µg/m^3, falling between 0.5 µg/m^3 and 0.75 µg/m^3. Only three sites have quarterly average concentrations of this pollutant outside this range (BLKY, BTUT, and TVKY). The site with the largest difference in its quarterly average concentrations of carbon tetrachloride is BTUT.

- For 2015, among the 20 sites with four quarterly average concentrations of carbon tetrachloride, the third quarter average concentrations were the highest for 17 of them. For 2016, among the 24 sites with four quarterly average concentrations of carbon tetrachloride, the second quarter average concentrations were the highest for 23 of them. However, the differences among the quarterly averages are so small, it makes little difference.

Figure 4-20. Comparison of Quarterly Average *p*-Dichlorobenzene Concentrations



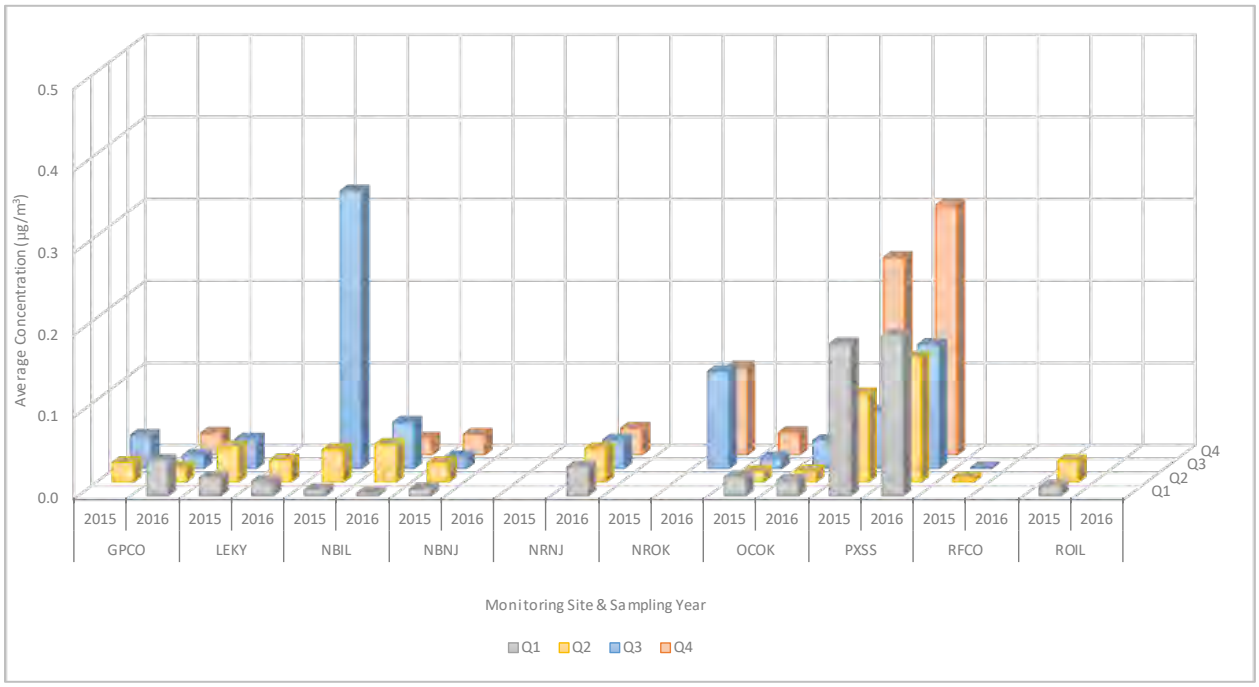
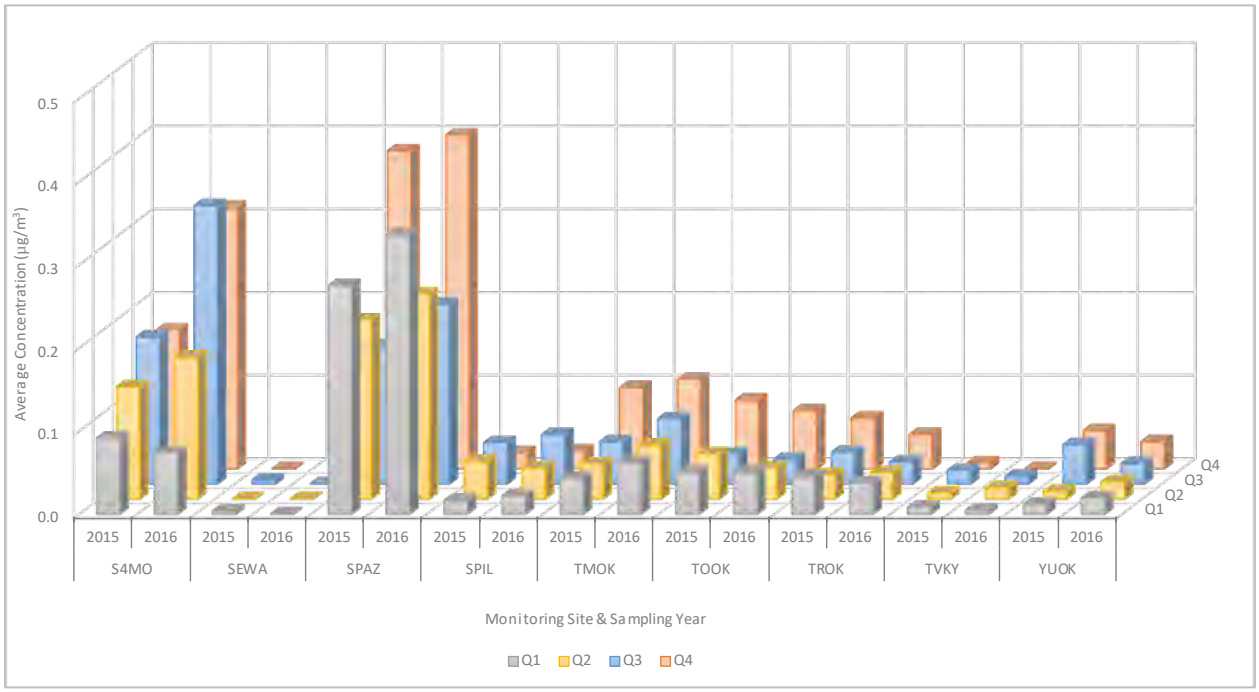


Figure 4-20. Comparison of Quarterly Average *p*-Dichlorobenzene Concentrations (Continued)



Observations from Figure 4-20 include the following:

- Figure 4-20 presents the site-specific quarterly average concentrations of *p*-dichlorobenzene.

- Quarterly average concentrations of *p*-dichlorobenzene range from 0 µg/m^3 (several sites and several quarters) to 0.40 ± 0.13 µg/m^3 (SPAZ, fourth quarter 2016).

- This figure shows which sites have consistently higher quarterly average concentrations (e.g., SPAZ, PXSS), consistently lower quarterly average concentrations (e.g., GLKY, SEWA), or where concentrations exhibited considerable variability among the quarters (e.g., NBIL, S4MO). NBIL and S4MO are the only sites who's quarterly average concentrations of *p*-dichlorobenzene vary by more than 0.25 µg/m^3. Conversely, the quarterly average concentrations of *p*-dichlorobenzene vary by less than 0.01 µg/m^3 for NRNJ.

- Among the sites sampling this pollutant that have four quarterly average concentrations available for a given year (44 site-year combinations), the fourth quarter average concentrations were most often the highest compared to other quarterly averages (21 in total, 12 for 2015 and nine for 2016). These can be seen by the orange bars extending higher in Figure 4-20 than the others; examples in the figure where this can readily be seen include the two Phoenix, Arizona sites and the three Tulsa, Oklahoma sites.

Figure 4-21. Comparison of Quarterly Average 1,2-Dichloroethane Concentrations

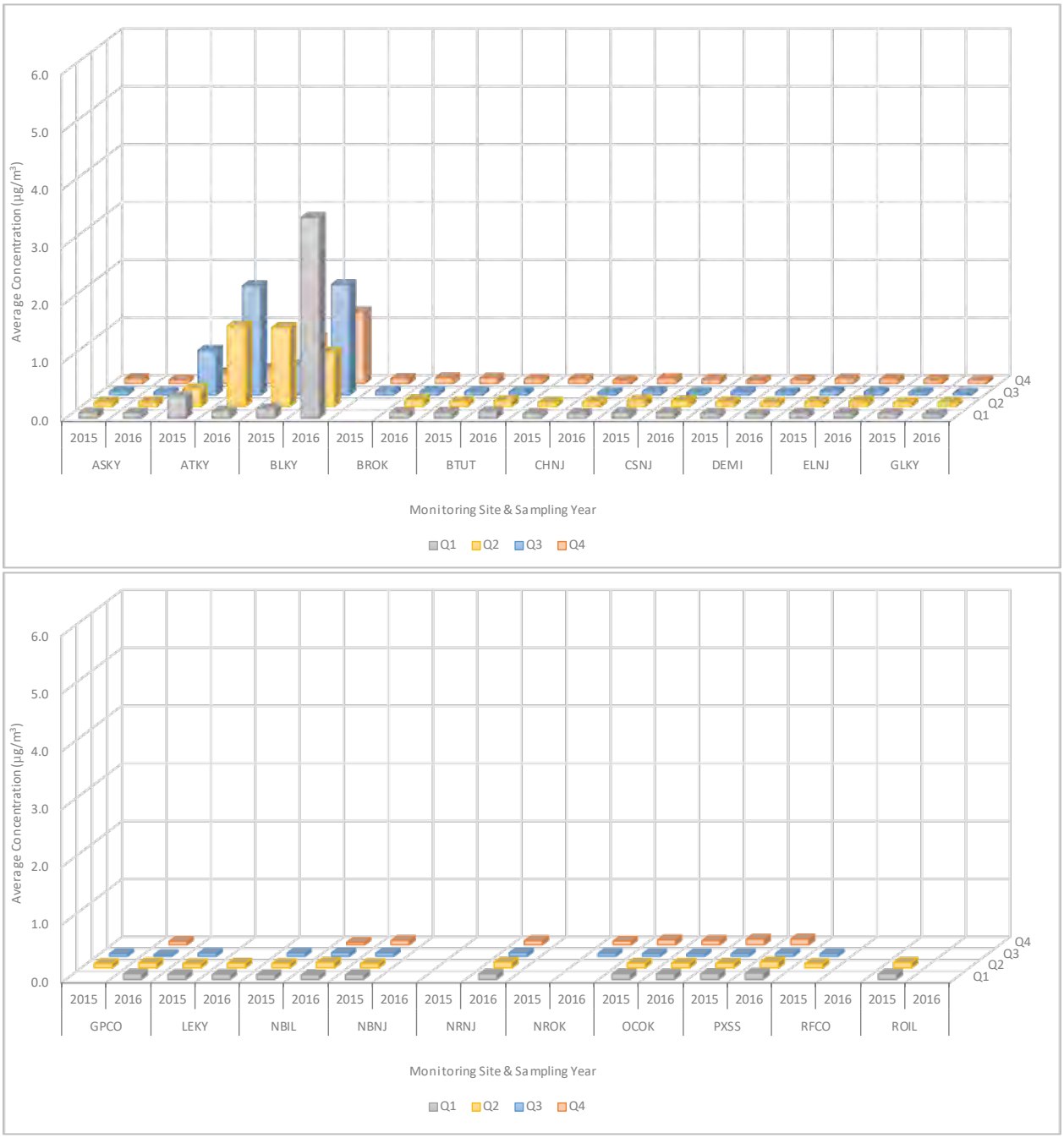
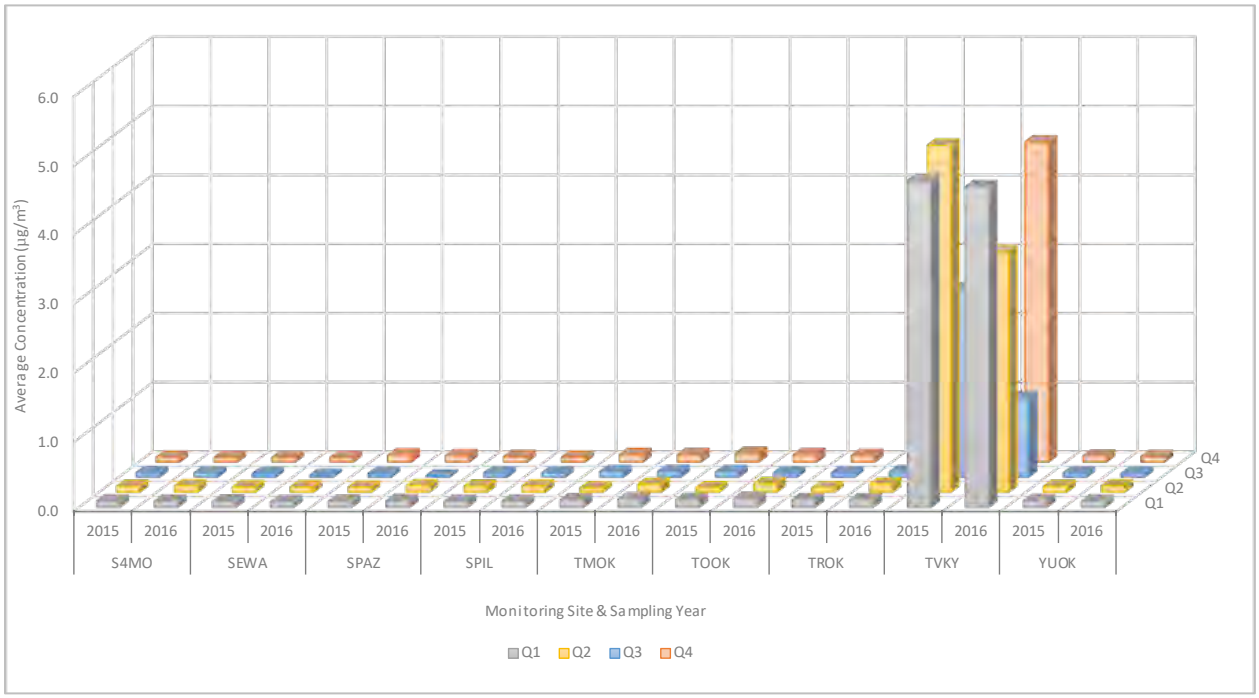


Figure 4-21. Comparison of Quarterly Average 1,2-Dichloroethane Concentrations (Continued)



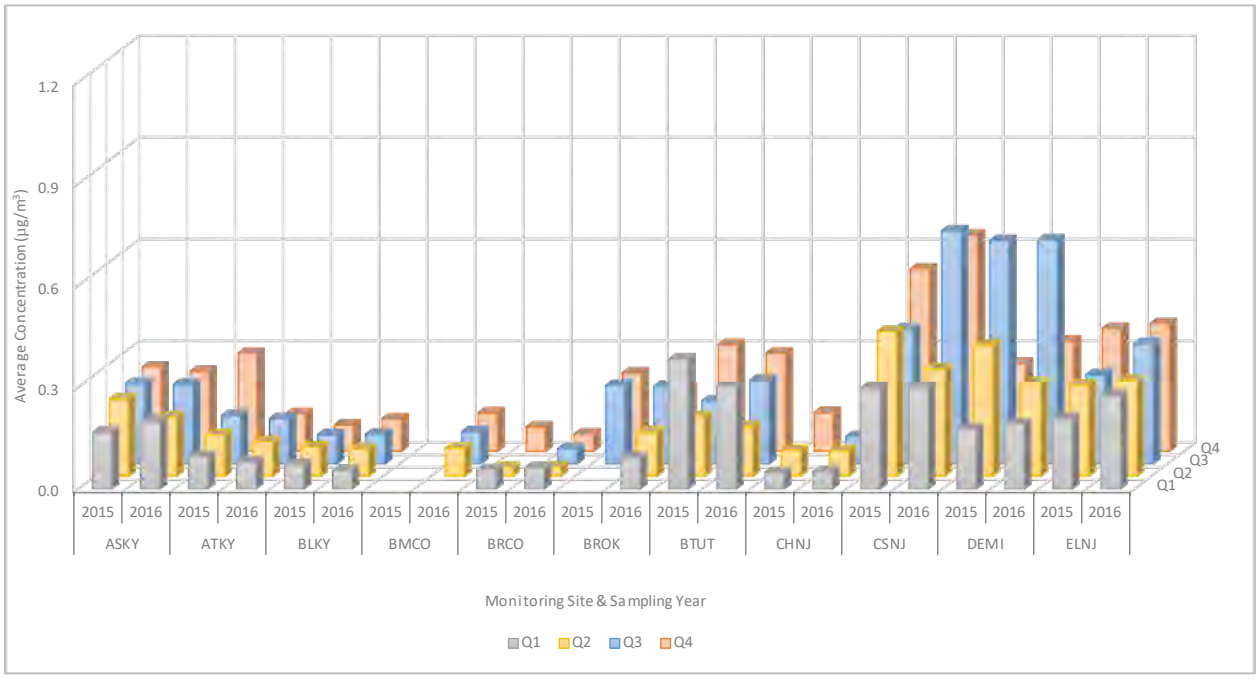
Observations from Figure 4-21 include the following:

- Figure 4-21 presents the site-specific quarterly average concentrations of 1,2-dichloroethane.

- Quarterly average concentrations of 1,2-dichloroethane range from 0.013 ± 0.019 µg/m^3 (SPAZ, third quarter 2016) to 5.02 ± 3.76 µg/m^3 (TVKY, second quarter 2015).

- This figure shows that besides the Calvert City, Kentucky sites (ATKY, BLKY, and TVKY), no other NMP site has a quarterly average concentration of 1,2-dichloroethane greater than 0.15 µg/m^3. Higher concentrations of this pollutant have consistently been measured at the Calvert City sites over the last several years. Few NMP sites (seven) have a quarterly average concentration greater than 0.1 µg/m^3. Excluding the Calvert City sites, TOOK has the highest quarterly average concentration of 1,2-dichloroethane (0.12 ± 0.02 µg/m^3, fourth quarter 2015, with similar averages for the first and second quarters of 2016).

Figure 4-22. Comparison of Quarterly Average Ethylbenzene Concentrations



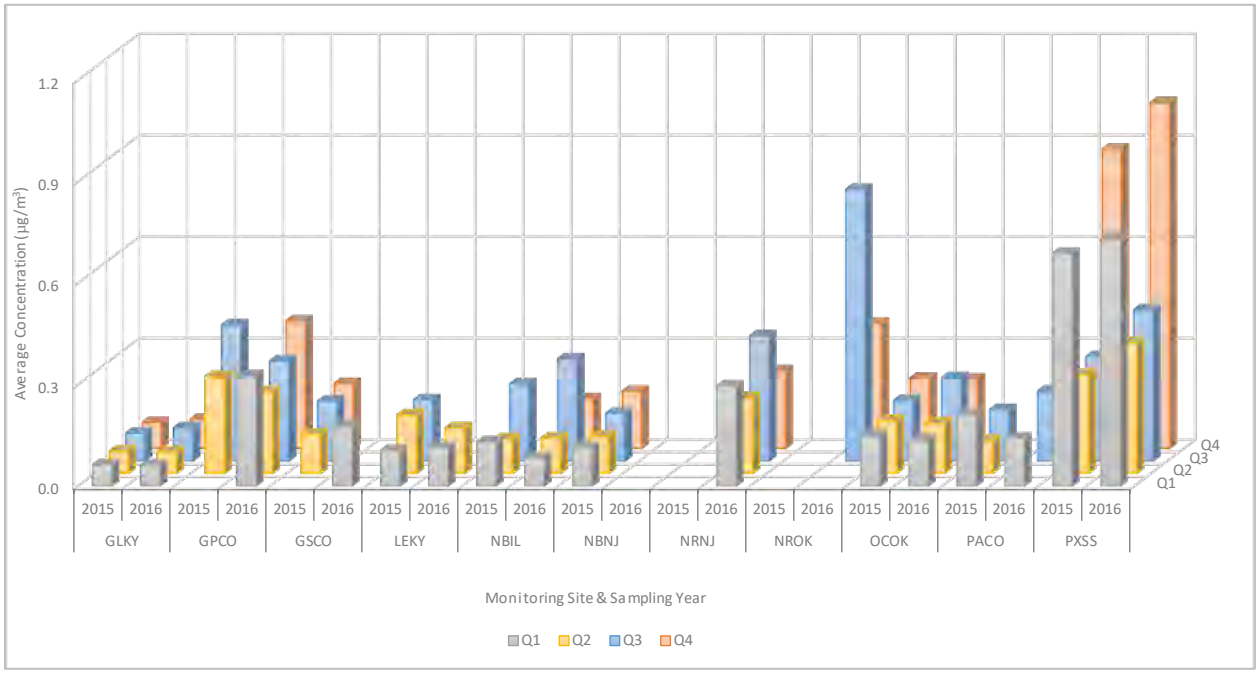
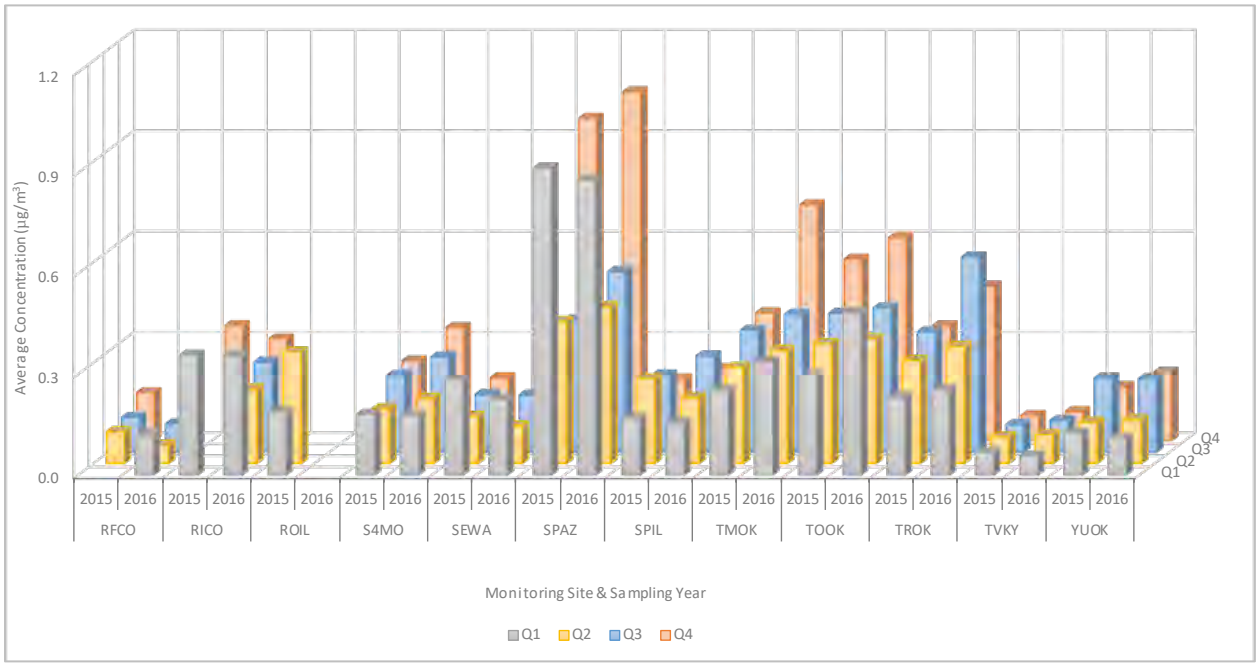


Figure 4-22. Comparison of Quarterly Average Ethylbenzene Concentrations (Continued)



Observations from Figure 4-22 includes the following:

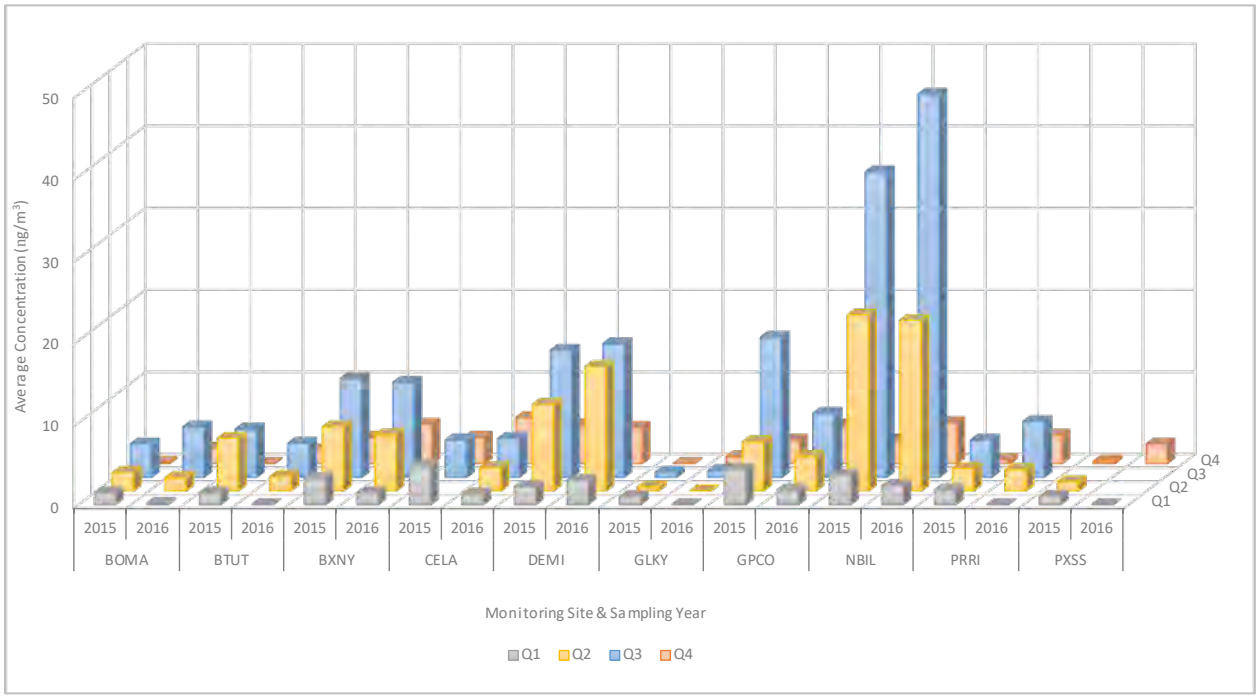
- Figure 4-22 presents the site-specific quarterly average concentrations of ethylbenzene.

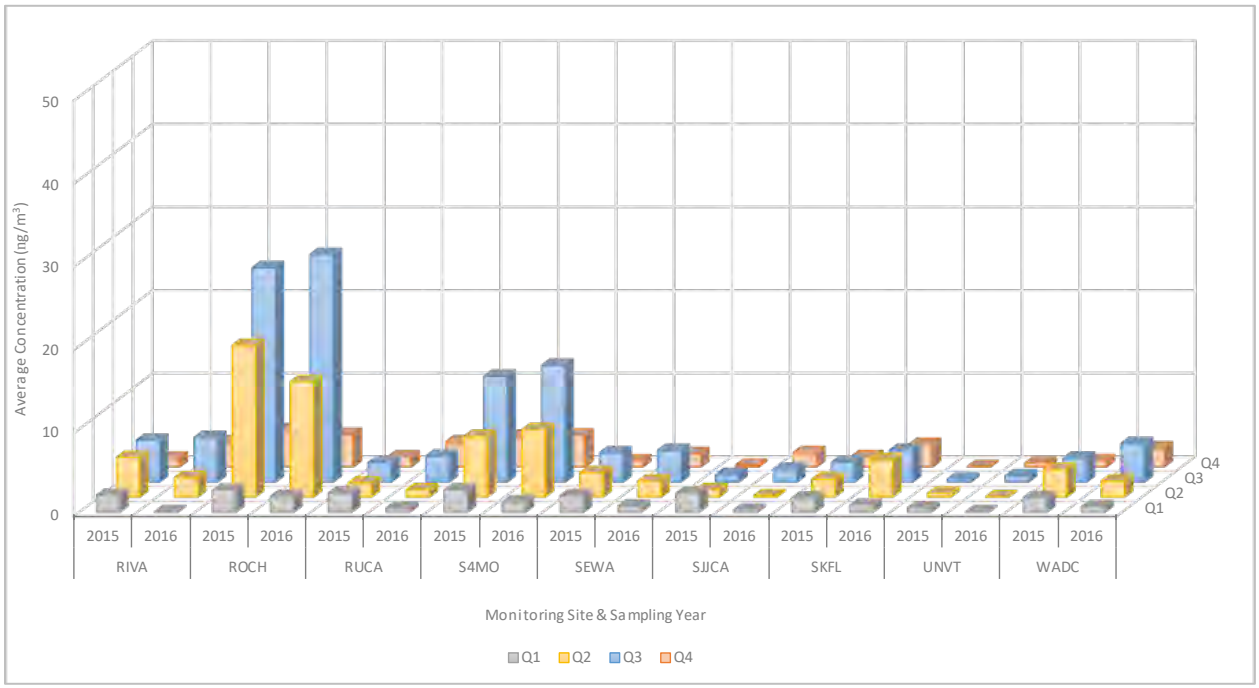
- Quarterly average concentrations of ethylbenzene range from 0.03 ± 0.03 µg/m^3 (BRCO, second quarter 2015, with a similar average for the second quarter of 2016) to 1.04 ± 0.74 µg/m^3 (SPAZ, fourth quarter 2016).

- Figure 4-22 shows which sites have consistently higher quarterly average concentrations (e.g., PXSS, SPAZ), consistently lower quarterly average concentration (e.g., BRCO, TVKY), and/or where concentrations exhibited considerable variability among the quarters (e.g., the Phoenix sites, DEMI, TMOK). The quarterly average concentrations for PXSS and SPAZ exhibit the most variability among the sites sampling ethylbenzene. For both sites, the first and fourth quarter average concentrations were considerably higher than the second and third quarter averages. This is true for both years. These are the only sites who's quarterly average concentrations of ethylbenzene vary by more than 0.5 µg/m^3 (though the averages for DEMI and TMOK just miss this cut-off). Conversely, sites who's quarterly average concentrations of ethylbenzene vary by less than 0.05 µg/m^3 include BLKY, BMCO, BRCO, GLKY, and TVKY.

- Among the sites sampling this pollutant that have four quarterly average concentrations available for a given year (46 site-year combinations), the third and fourth quarter average concentrations were often higher than the other quarterly averages (38 in total, 17 for the third quarter and 21 for the fourth quarter). These can be seen by the blue and orange bars extending higher in Figure 4-22 than the others; examples in the figure where this can readily be seen include ASKY, ELNJ, OCOK, TROK, YUOK.

Figure 4-23. Comparison of Quarterly Average Fluorene Concentrations





Observations from Figure 4-23 include the following:

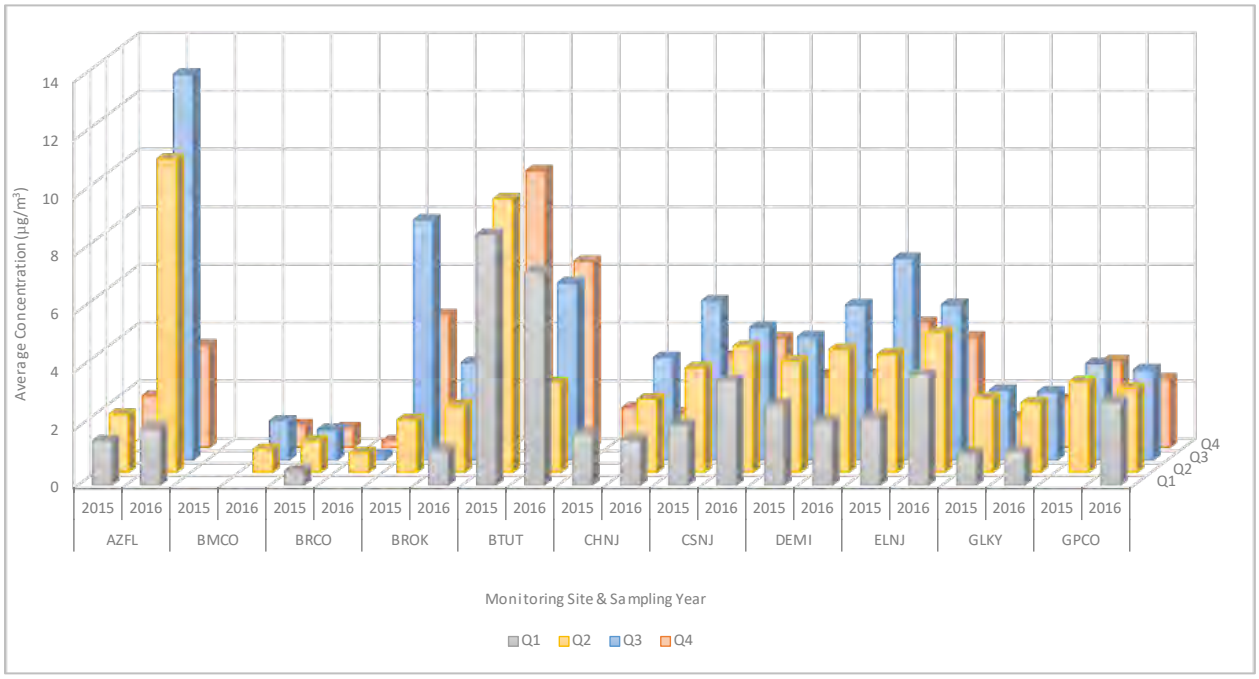
- Figure 4-23 presents the site-specific quarterly average concentrations of fluorene. This figure resembles Figure 4-14 for acenaphthene.

- Quarterly average concentrations of fluorene range from 0 ng/m^3 (several sites for several quarters) to 46.67 ± 12.88 ng/m^3 (NBIL, third quarter 2016).

- The highest quarterly average concentrations for fluorene for many of the sites were calculated for the second and third quarters of each year (during the warmer months of the years), as indicated by the yellow and blue bars in Figure 4-23.

- NBIL has the highest quarterly average concentrations of fluorene; the third quarter averages for both years are greater than 30 ng/m^3. NBIL and ROCH are the only NMP sites for which quarterly average concentrations of fluorene greater than 20 ng/m^3 were calculated. Other sites with quarterly average concentrations greater than 10 ng/m^3 include BXNY, DEMI, GPCO, and S4MO, all of which were calculated for either the second or third quarter of a given year.

Figure 4-24. Comparison of Quarterly Average Formaldehyde Concentrations



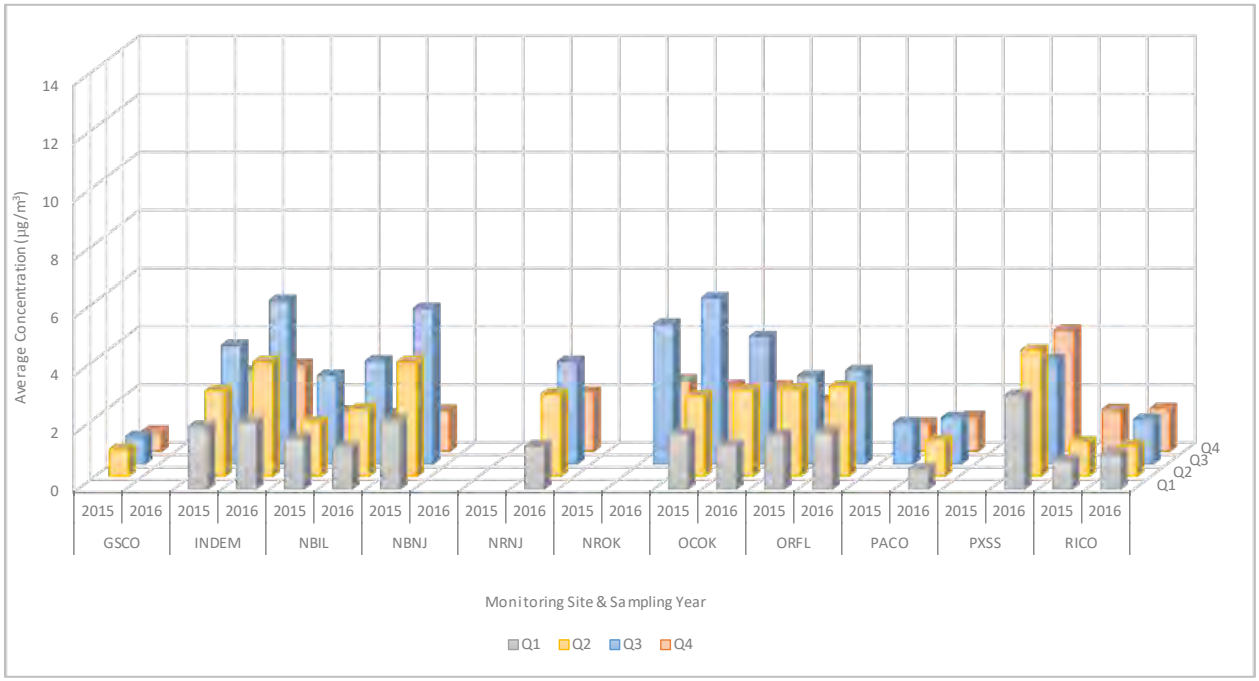
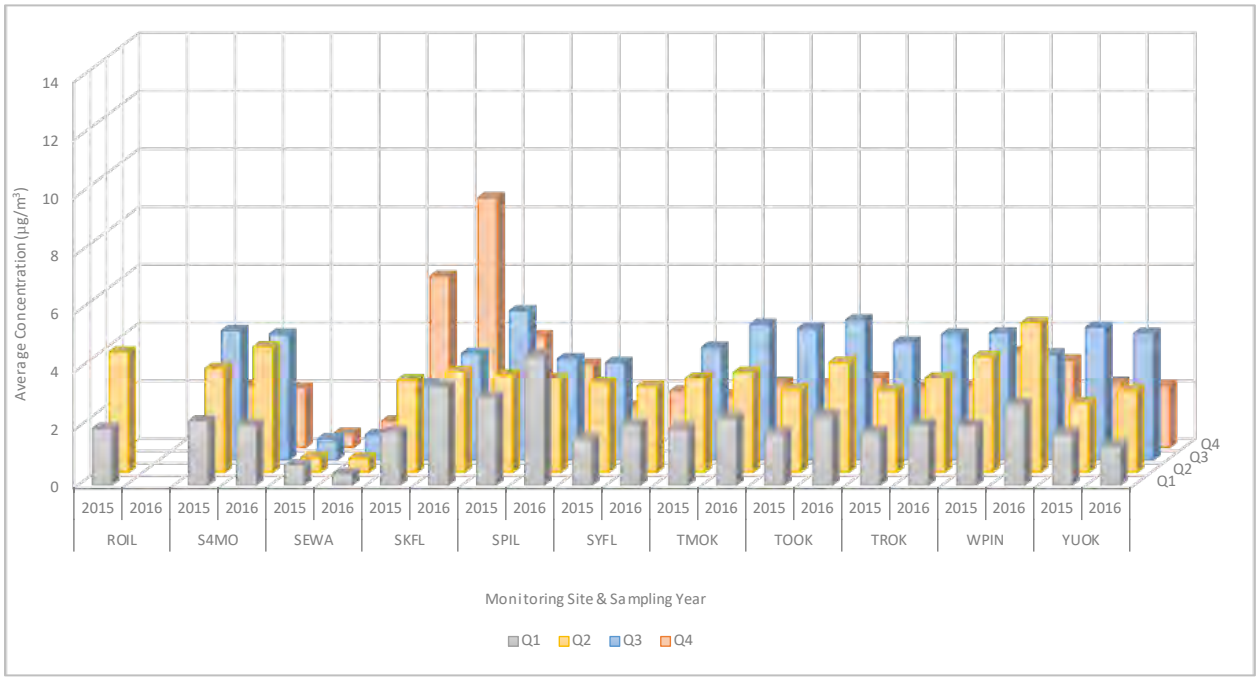


Figure 4-24. Comparison of Quarterly Average Formaldehyde Concentrations (Continued)



Observations from Figure 4-24 include the following:

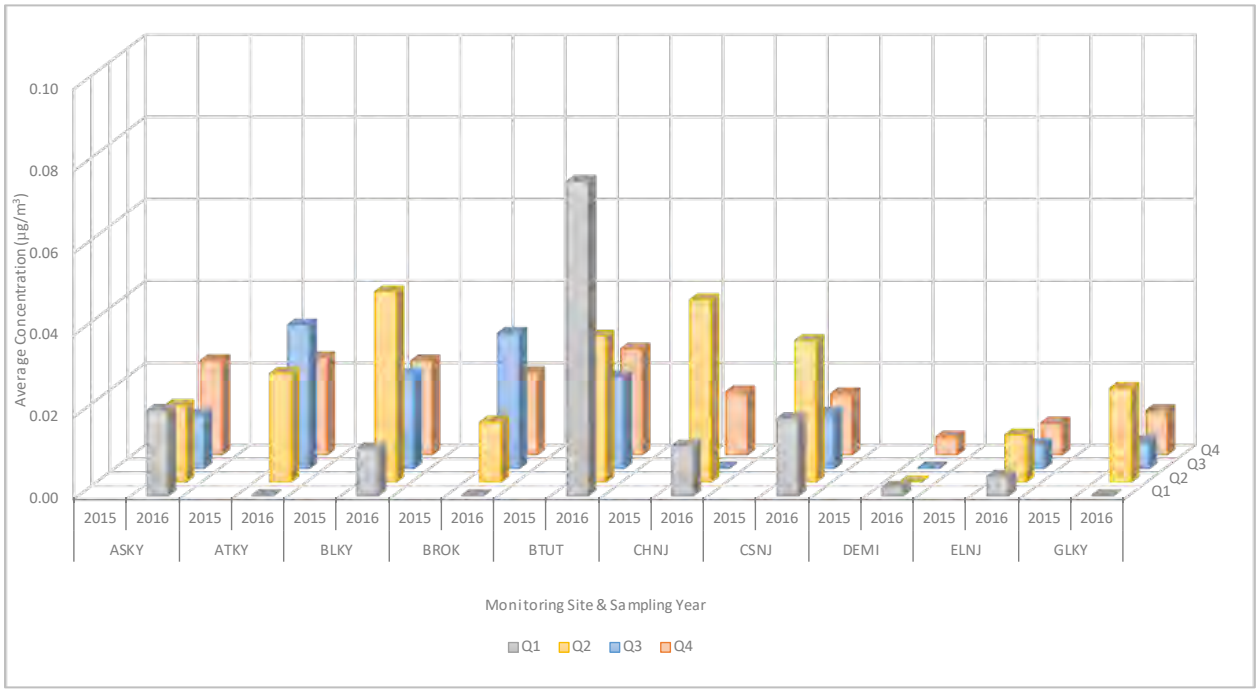
- Figure 4-24 presents the site-specific quarterly average concentrations of formaldehyde.

- Quarterly average concentrations of formaldehyde range from 0.16 ± 0.09 µg/m^3 (BRCO, third quarter 2016) to 13.30 ± 2.55 µg/m^3 (AZFL, third quarter 2016).

- This figure shows which sites have consistently higher quarterly average concentrations (e.g., BTUT), consistently lower quarterly average concentration (e.g., BRCO, SEWA), or where concentrations exhibited considerable variability among the quarters (e.g., AZFL, BROK). AZFL's quarterly average concentrations exhibit the most variability among the sites, particularly for 2016. Other sites besides AZFL who's quarterly average concentrations of formaldehyde vary by more than 5 µg/m^3 include BROK, BTUT, and SKFL. Conversely, sites who's quarterly average concentrations of formaldehyde vary by less than 1 µg/m^3 include the Garfield County, Colorado sites (BMCO, BRCO, GSCO, PACO, and RICO), GPCO, and SEWA.

- Among the sites sampling this pollutant that have four quarterly average concentrations available for a given year (45 site-year combinations), the third quarter average concentrations were often higher than the other quarterly averages (35 in total, 17 for 2015 and 18 for 2016). These can be seen by the blue bars extending higher in Figure 4-24 than the others; examples include AZFL, BROK, ELNJ, INDEM, OCOK, TOOK, TMOK, TROK, and YUOK.

Figure 4-25. Comparison of Quarterly Average Hexachloro-1,3-butadiene Concentrations



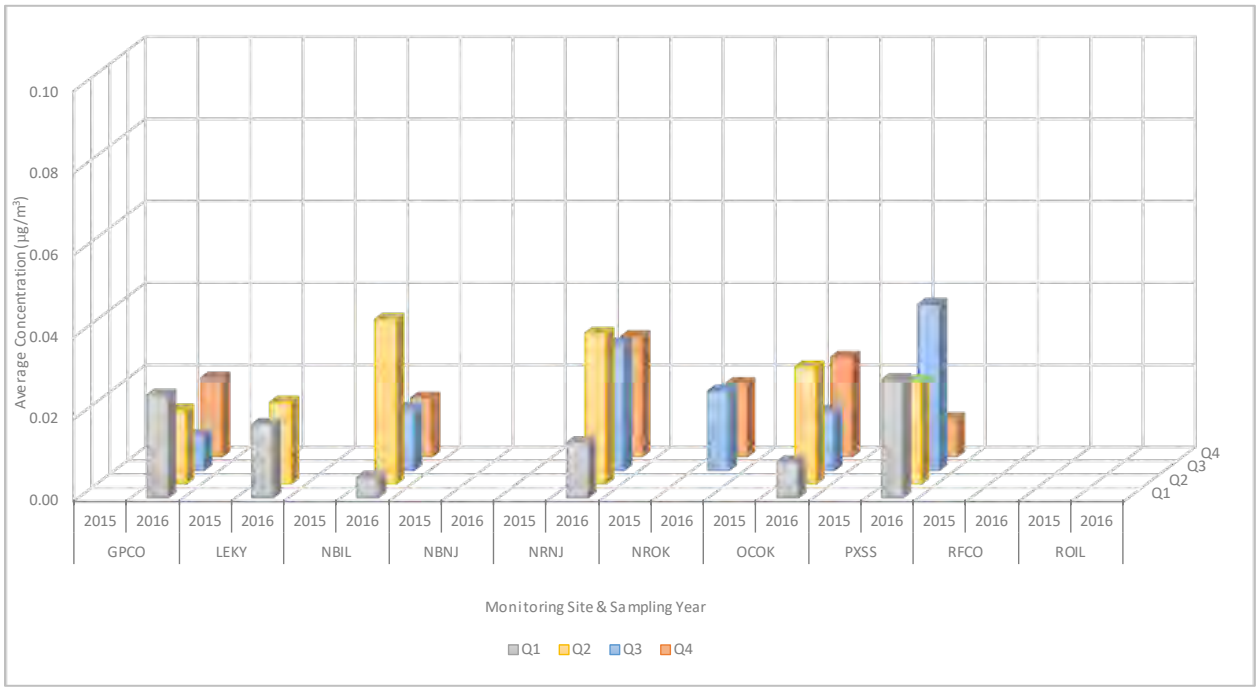
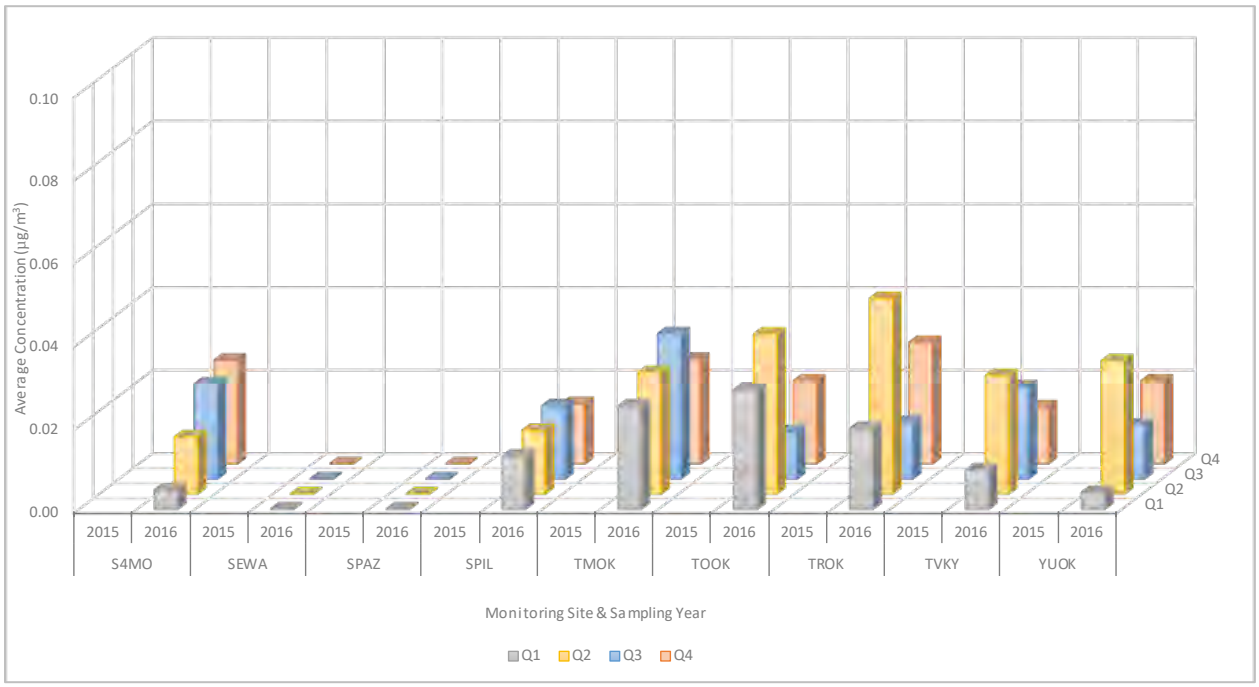


Figure 4-25. Comparison of Quarterly Average Hexachloro-1,3-butadiene Concentrations (Continued)



Observations from Figure 4-25 include the following:

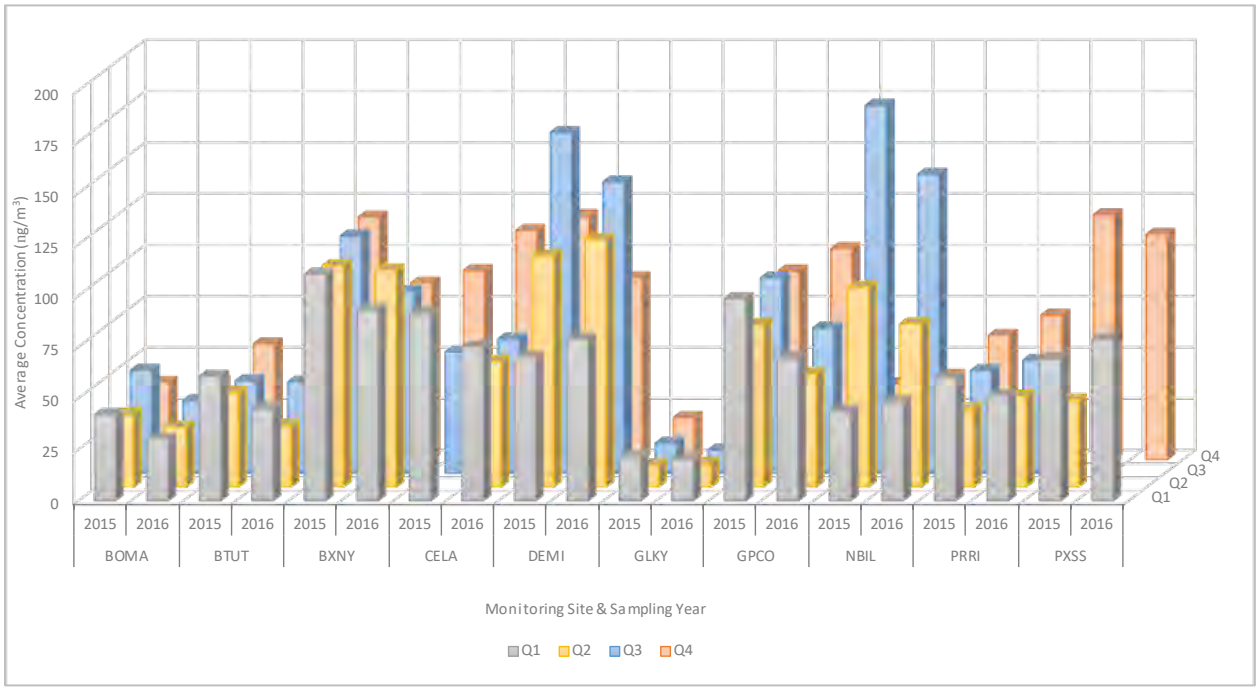
- Figure 4-25 presents the site-specific quarterly average concentrations of hexachloro-1,3-butadiene. Concentrations of hexachloro-1,3-butadiene for 2015 were affected by a standard contamination issue that resulted in the invalidation of a large portion of the 2015 data for this pollutant. Thus, no quarterly average concentrations of hexachloro-1,3-butadiene are presented for 2015 in Figure 4-25.

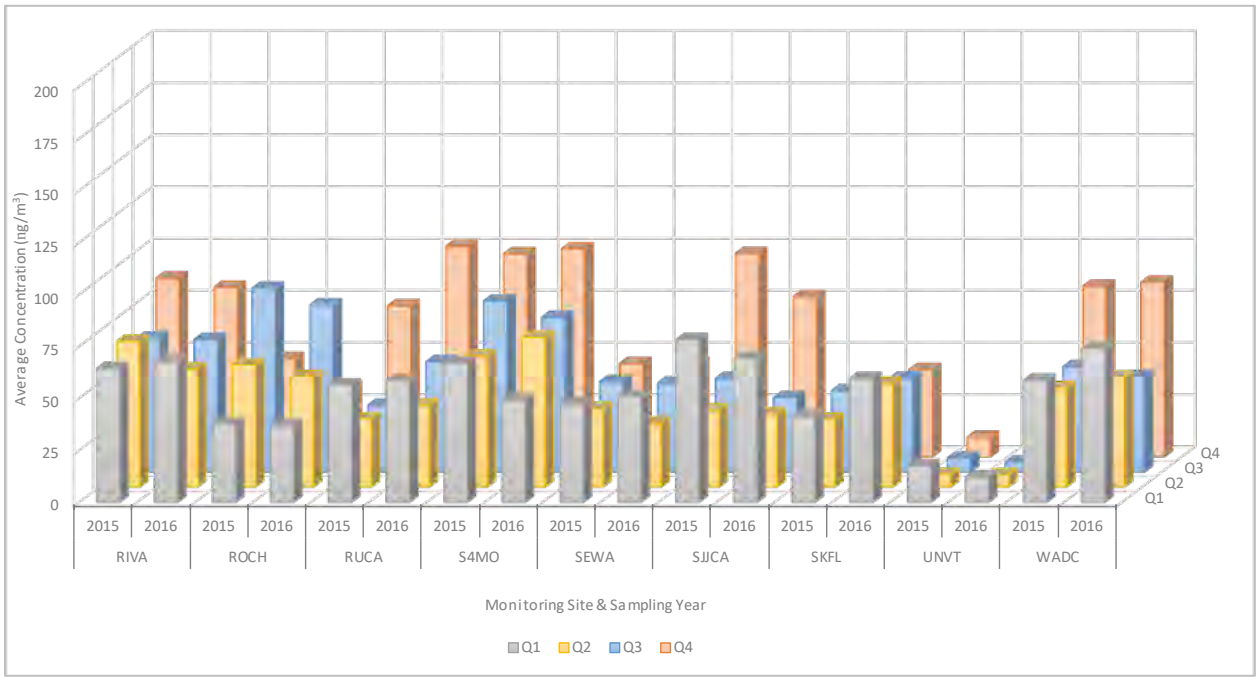
- Quarterly average concentrations of hexachloro-1,3-butadiene range from 0 µg/m^3 (several sites for several quarter) to 0.08 ± 0.14 µg/m^3 (BTUT, first quarter 2016). This quarterly average concentration for BTUT is the only quarterly average concentration greater than 0.05 µg/m^3. The maximum concentration of hexachloro-1,3-butadiene across the program was measured at BTUT and is more than six times higher than the next highest hexachloro-1,3-butadiene concentration measured across the two years of sampling.

- Sites who's quarterly average concentrations of hexachloro-1,3-butadiene vary by more than 0.035 µg/m^3 include BTUT, CHNJ, and NBIL. Conversely, sites who's quarterly average concentrations of hexachloro-1,3-butadiene vary by less than 0.005 µg/m^3 include DEMI and SPIL.

- Many of the measurements of hexachloro-1,3-butadiene are either non-detects or less than the detection limit (80 percent of the measurements of hexachloro-1,3-butadiene were non-detects). This indicates that a large number of substituted zeroes are included in the quarterly average calculations, including several sites where this pollutant was not detected at all (e.g., SPAZ and SEWA).

Figure 4-26. Comparison of Quarterly Average Naphthalene Concentrations





Observations from Figure 4-26 include the following:

- Figure 4-26 presents the site-specific quarterly average concentrations of naphthalene.

- Quarterly average concentrations of naphthalene range from 4.87 ± 0.81 ng/m^3 (UNVT, third quarter 2016) to 179.35 ± 54.50 ng/m^3 (NBIL, third quarter 2015). Eight NMP sites have at least one quarterly average concentration of naphthalene greater than 100 ng/m^3. Conversely, UNVT is the only NMP sites with quarterly average concentrations of naphthalene less than 10 ng/m^3.

- This figure shows which sites have consistently higher quarterly average concentrations (e.g., BXNY, DEMI), consistently lower quarterly average concentration (e.g., GLKY, UNVT), or where concentrations exhibited considerable variability among the quarters (e.g., NBIL). Other sites besides NBIL who's quarterly average concentrations of naphthalene vary by more than 75 ng/m^3 include DEMI and PXSS. Conversely, sites who's quarterly average concentrations of naphthalene vary by less than 15 ng/m^3 include GLKY, SEWA, and UNVT.

- Among the sites sampling this pollutant that have four quarterly average concentrations available for a given year (35 site-year combinations), the fourth quarter average concentrations were often higher than the other quarterly averages (17 in total, 7 for 2015 and 10 for 2016). These can be seen by the orange bars extending higher in Figure 4-26 than the others; examples include RIVA, S4MO, SJJCA, and WADC. Note that for the sites with the highest quarterly average naphthalene concentrations (NBIL and DEMI), the highest quarterly averages were calculated for the third quarter of both years.

5.0 Sites in Arizona

This section summarizes those data from samples collected at the NATTS and UATMP sites in Arizona and generated by ERG, EPA's contract laboratory for the NMP, over the 2015 and 2016 monitoring efforts. This section also examines the spatial and temporal characteristics of the ambient monitoring concentrations and reviews them through the context of risk. Readers are encouraged to refer to Sections 1 through 4 for detailed discussions and definitions regarding the various data analyses presented below.

Data generated by sources other than ERG, EPA's contract laboratory for the NMP, are not included in the data analyses contained in this report.

5.1 Site Characterization

This section characterizes the Arizona monitoring sites by providing a description of the nearby area surrounding the monitoring sites; plotting emissions sources surrounding the monitoring sites; and presenting traffic data and other characterizing information for the sites. This information is provided to give the reader insight regarding factors that may influence the air quality near the sites and assist in the interpretation of the ambient measurements.

The Arizona monitoring sites are located in Phoenix, Arizona. Figures 5-1 and 5-2 present composite satellite images retrieved from ArcGIS Explorer showing the monitoring sites and their immediate surroundings. Figure 5-3 identifies nearby point source emissions locations by source category, as reported in the 2014 NEI for point sources, version 1. Note that only sources within 10 miles of the sites are included in the facility counts provided in Figure 5-3. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have a direct effect on the air quality at the monitoring sites. Further, this boundary provides both the proximity of emissions sources to the monitoring sites as well as the quantity of such sources within a given distance of the sites. Sources outside the 10-mile boundaries are still visible on the map for reference but have been grayed out to emphasize emissions sources within the boundary. Table 5-1 provides supplemental geographical information such as land use, location setting, and locational coordinates. Each figure and table is discussed in detail in the paragraphs that follow.

Figure 5-1. Phoenix, Arizona (PXSS) Monitoring Site

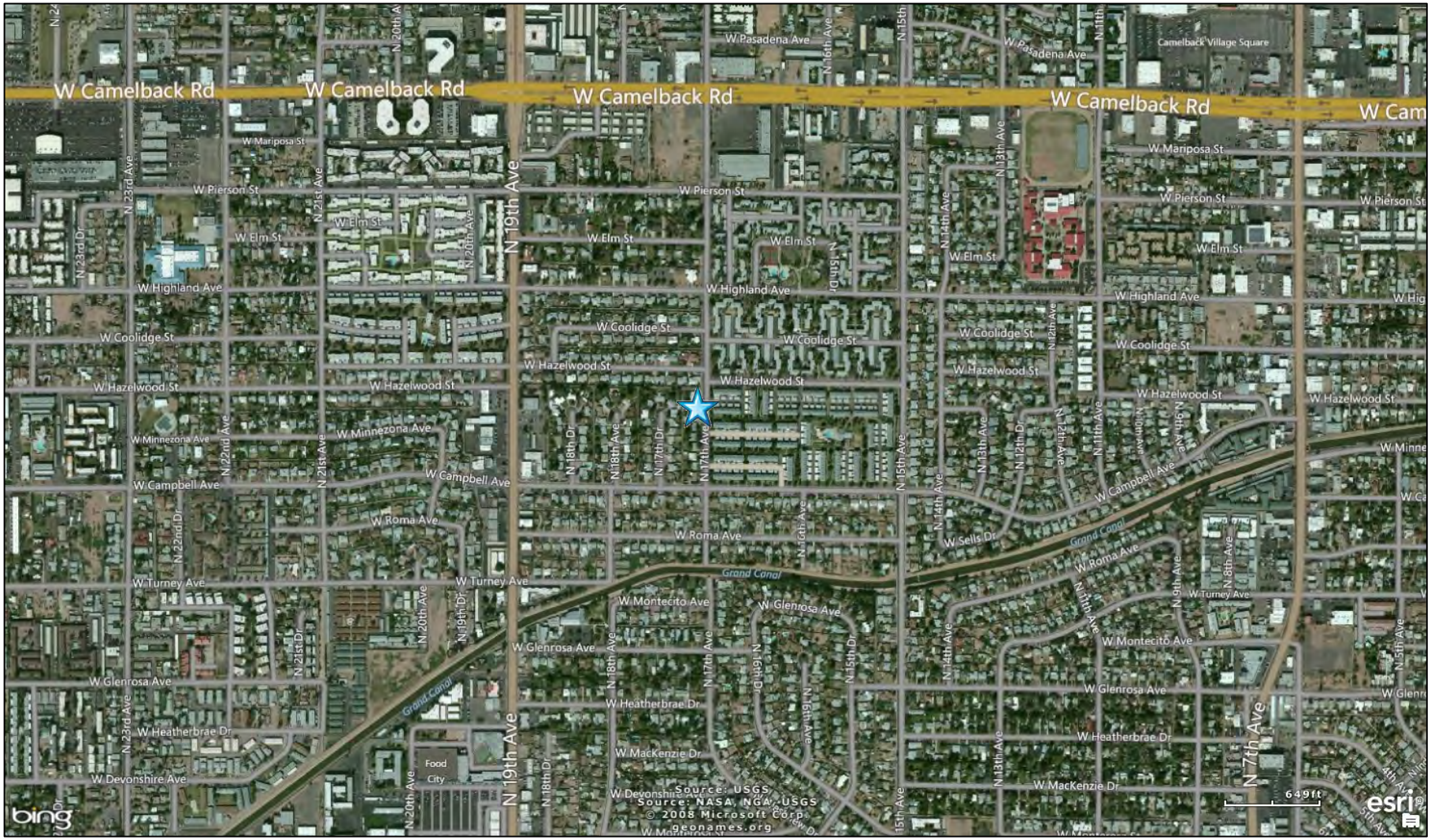


Figure 5-2. South Phoenix, Arizona (SPAZ) Monitoring Site

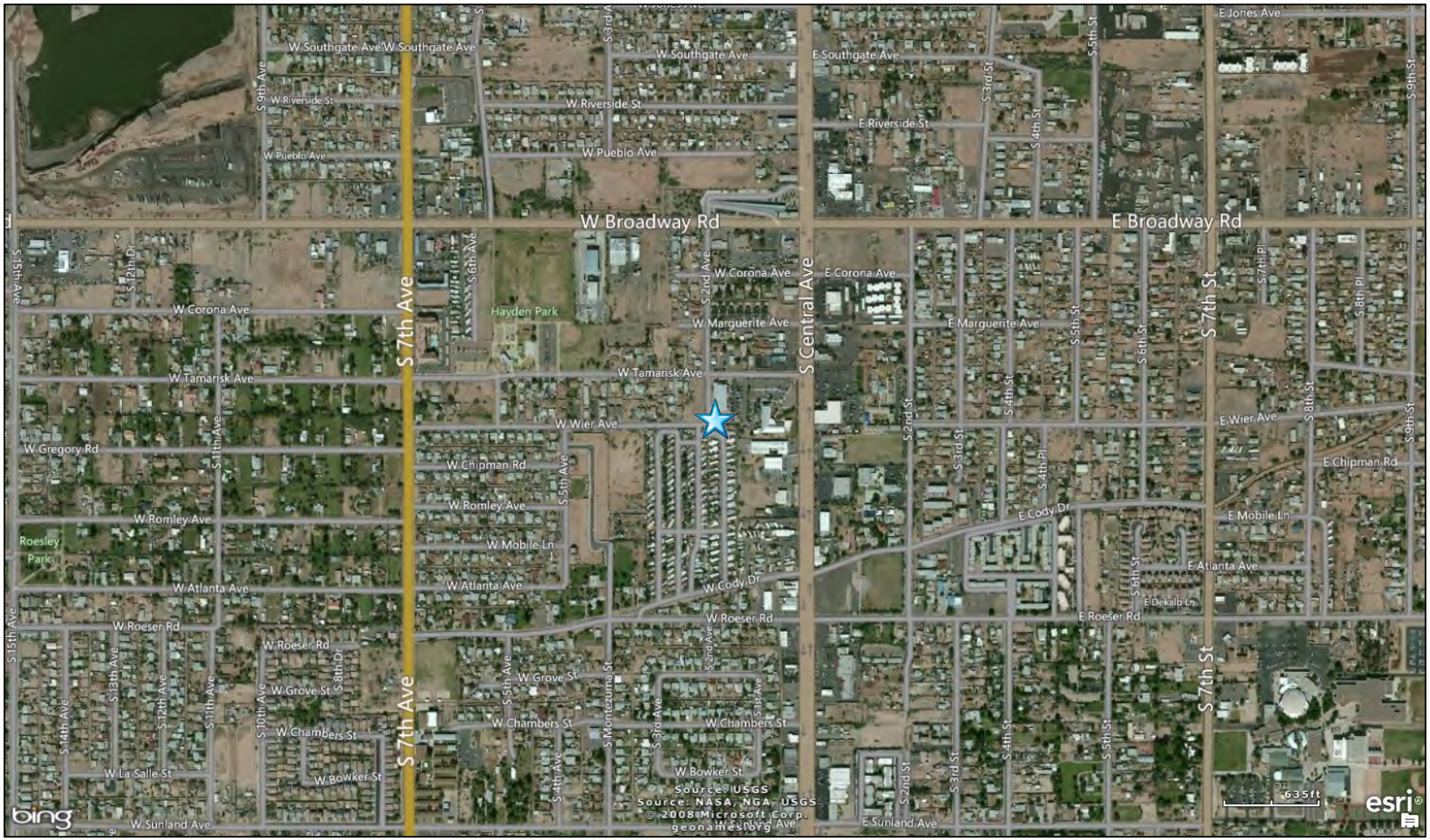


Figure 5-3. NEI Point Sources Located Within 10 Miles of PXSS and SPAZ

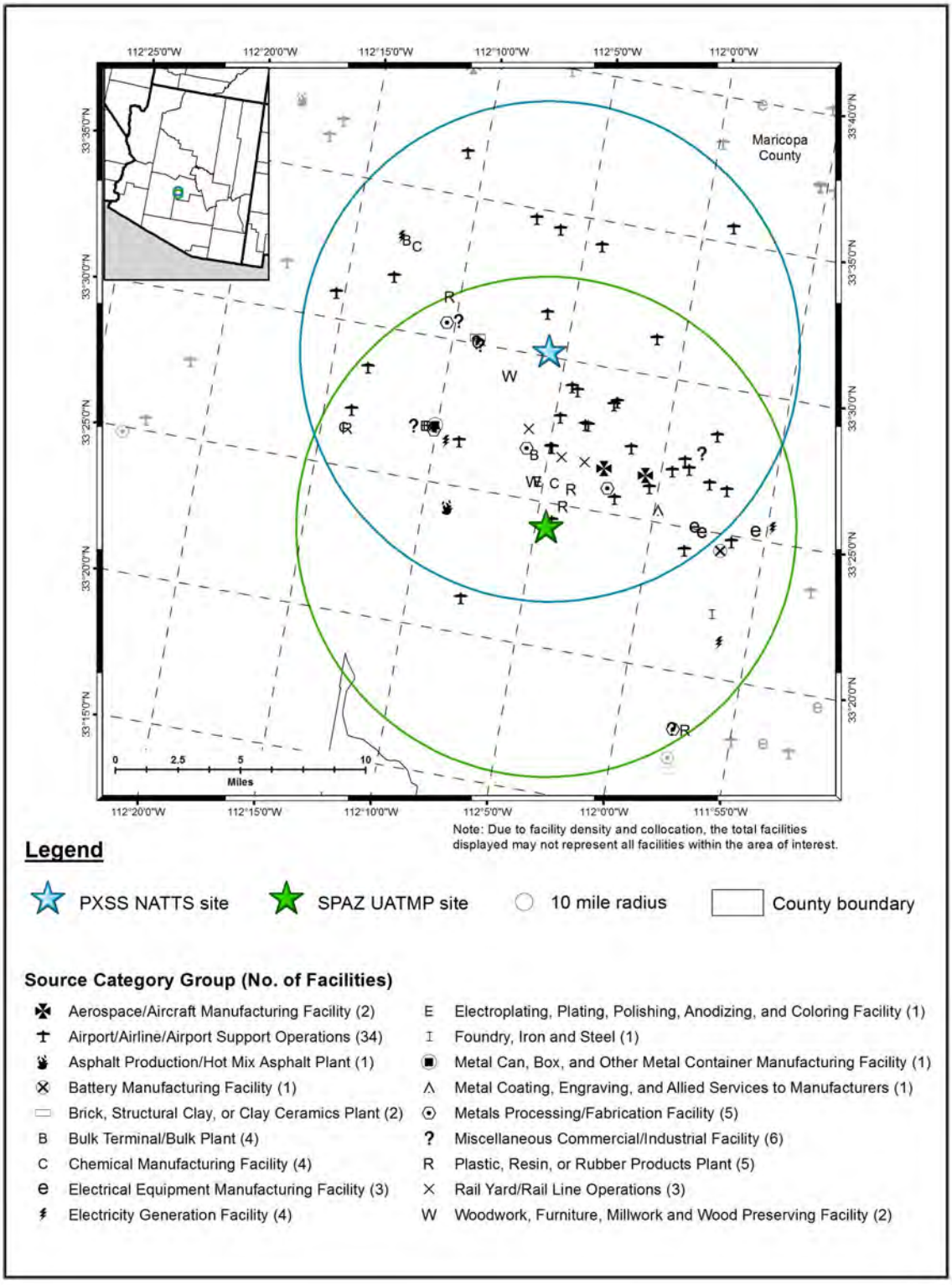


Table 5-1. Geographical Information for the Arizona Monitoring Sites

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Annual Average Daily Traffic[1]	Intersection Used for Traffic Data
PXSS	04-013-9997	Phoenix	Maricopa	Phoenix-Mesa-Scottsdale, AZ	33.503833, -112.095767	Residential	Urban/City Center	35,103	W Camelback Rd, on either side of N 19th Ave
SPAZ	04-013-4003	Phoenix	Maricopa	Phoenix-Mesa-Scottsdale, AZ	33.403160 -112.075330	Residential	Urban/City Center	21,601	Central Ave, south of W Tamarisk St

[1]AADT reflects 2010 data for PXSS and 2015 data for SPAZ (AZ DOT, 2017)
BOLD ITALICS = EPA-designated NATTS Site

PXSS is located in central Phoenix. Figure 5-1 shows that PXSS is located in a residential area on North 17th Avenue. The Grand Canal is shown along the bottom of Figure 5-1. The monitoring site is approximately three-quarters of a mile east of I-17 and 2 miles north of I-10. Figure 5-2 shows that SPAZ is located in South Phoenix near the intersection of West Tamarisk Street and South Central Avenue. SPAZ is surrounded by residential properties to the west and south and commercial properties to the east. SPAZ is located approximately 1 mile south of I-17/I-10.

PXSS is located approximately 7 miles north of SPAZ. The majority of emissions sources are located between the sites, to the south of PXSS and north of SPAZ, as shown in Figure 5-3. The source category with the greatest number of emissions sources near these monitoring sites is the airport source category, which includes airports and related operations as well as small runways and heliports, such as those associated with hospitals or television stations. The emissions source nearest PXSS is a hospital heliport while the source nearest SPAZ is a heliport at a police station.

In addition to providing city, county, CBSA, and land use/location setting information, Table 5-1 also contains traffic volume information for each site as well as the location for which the traffic volume was obtained. This information is provided because emissions from motor vehicles can significantly affect concentrations measured at a given monitoring site. PXSS experiences a higher traffic volume compared to SPAZ, although the traffic volumes near both sites rank in the middle of the range compared to traffic volumes near other NMP sites. These traffic volumes were obtained for roadways fairly close to PXSS and SPAZ (West Camelback Road and Central Avenue, respectively).

5.2 Pollutants of Interest

The risk-based screening process described in Section 3.2 was performed for each Arizona site to identify site-specific "pollutants of interest," which allows analysts and readers to focus on a subset of pollutants through the context of risk. For each site, each pollutant's preprocessed daily measurement was compared to its associated risk screening value. If the concentration was greater than the risk screening value, then the concentration "failed the screen." The site-specific results of this risk-based screening process are presented in Table 5-2 and incorporate measurements from both 2015 and 2016. Pollutants of interest are those for which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens and are shaded in gray in Table 5-2. It is important to note which pollutants

were sampled for at each site when reviewing the results of this analysis. VOCs, carbonyl compounds, PAHs, and metals (PM_{10}) were sampled for at PXSS; VOCs were the only pollutants sampled for at SPAZ.

Table 5-2. 2015-2016 Risk-Based Screening Results for the Arizona Monitoring Sites

Pollutant	Screening Value (µg/m^3)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Phoenix, Arizona - PXSS						
Benzene	0.13	118	118	100.00	11.27	11.27
Carbon Tetrachloride	0.17	118	118	100.00	11.27	22.54
Arsenic (PM_{10})	0.00023	114	120	95.00	10.89	33.43
1,3-Butadiene	0.03	114	118	96.61	10.89	44.32
1,2-Dichloroethane	0.038	108	110	98.18	10.32	54.63
Acetaldehyde	0.45	91	91	100.00	8.69	63.32
Formaldehyde	0.077	91	91	100.00	8.69	72.02
p-Dichlorobenzene	0.091	88	112	78.57	8.40	80.42
Naphthalene	0.029	88	106	83.02	8.40	88.83
Ethylbenzene	0.4	65	118	55.08	6.21	95.03
Hexachloro-1,3-butadiene	0.045	16	18	88.89	1.53	96.56
Nickel (PM_{10})	0.0021	15	120	12.50	1.43	97.99
Manganese (PM_{10})	0.03	7	120	5.83	0.67	98.66
Propionaldehyde	0.8	5	91	5.49	0.48	99.14
Benzo(a)pyrene	0.00057	3	76	3.95	0.29	99.43
Cadmium (PM_{10})	0.00056	2	120	1.67	0.19	99.62
Beryllium (PM_{10})	0.00042	1	120	0.83	0.10	99.71
Chloroprene	0.0021	1	1	100.00	0.10	99.81
1,2-Dibromoethane	0.0017	1	1	100.00	0.10	99.90
Lead (PM_{10})	0.015	1	120	0.83	0.10	100.00
Total		1,047	1,889	55.43		
South Phoenix, Arizona - SPAZ						
Benzene	0.13	63	63	100.00	18.48	18.48
Carbon Tetrachloride	0.17	63	63	100.00	18.48	36.95
1,3-Butadiene	0.03	61	62	98.39	17.89	54.84
p-Dichlorobenzene	0.091	54	62	87.10	15.84	70.67
1,2-Dichloroethane	0.038	52	56	92.86	15.25	85.92
Ethylbenzene	0.4	46	63	73.02	13.49	99.41
1,2-Dichloropropane	0.4	1	1	100.00	0.29	99.71
Trichloroethylene	0.2	1	9	11.11	0.29	100.00
Total		341	379	89.97		

Observations from Table 5-2 include the following:

- The number of pollutants failing screens varied significantly between the two monitoring sites; this is expected given the difference in pollutants measured at each site.

- Concentrations of 20 pollutants failed at least one screen for PXSS; 55 percent of concentrations for these 20 pollutants were greater than their associated risk screening value (or failed screens).

- Concentrations of 10 pollutants contributed to 95 percent of failed screens for PXSS and therefore were identified as pollutants of interest for PXSS. These 10 include two carbonyl compounds, six VOCs, one PM_{10} metal, and one PAH.

- PXSS failed the second highest number of screens (1,047) among NMP sites (refer to Table 4-9 of Section 4.2), and is one of only three sites with more than 1,000 failed screens. However, the failure rate for PXSS, when incorporating all pollutants with screening values, is relatively low, at just less than 22 percent. This is due primarily to the relatively high number of pollutants sampled for at this site, as discussed in Section 4.2 and the previous section.

- Concentrations of eight pollutants failed screens for SPAZ; approximately 90 percent of concentrations for these six pollutants were greater than their associated risk screening value (or failed screens). This percentage is greater than the percentage for PXSS. However, nearly all of the measured detections for the pollutants listed for SPAZ failed screens, ranging from a 73 percent failure rate for ethylbenzene to a 100 percent failure rate for benzene and carbon tetrachloride; for PXSS, the percentage of screens failed for each individual pollutant is more varied, ranging from less than 1 percent for lead to 100 percent for six pollutants.

- Concentrations of six pollutants that failed screens for SPAZ contributed to 95 percent of failed screens for SPAZ and therefore were identified as pollutants of interest for this site.

- Of the pollutants of interest in common for these sites (VOCs only), benzene and carbon tetrachloride were detected in all valid samples collected and failed 100 percent of screens for each site. Other VOCs, such as 1,2-dichloroethane, 1,3-butadiene, and *p*-dichlorobenzene were detected frequently and also failed the majority of screens. Formaldehyde and acetaldehyde were detected in all of the valid samples collected at PXSS and also failed 100 percent of screens for this site.

For each of the data analyses described in the remaining section, the focus is on the site-specific pollutants of interest identified via the risk-based screening process, as described in Section 3.4.2.

5.3 Concentrations

This section presents various concentration averages used to characterize air toxics concentration levels at the Arizona monitoring sites. Where applicable, the following calculations and data analyses were performed for each of the site-specific pollutants of interest:

- Time period-based concentration averages (quarterly and annual) are provided for each monitoring site for each year.
- The range of measurements and annual average concentrations are presented graphically for each site to illustrate how the site's concentrations compare to the program-level averages, as presented in Section 4.1.
- Concentration averages and other statistical metrics for 2015, 2016, and from previous years of monitoring are presented in order to characterize concentration trends at each site.

Each data analysis is performed where the applicable criteria is met (as specified in the appropriate sections below) and is limited to the site-specific pollutants of interest. However, site-specific statistical summaries for all pollutants sampled for at PXSS and SPAZ are provided in Appendices J, M, N, and O.

5.3.1 2015 and 2016 Concentration Averages

Quarterly and annual concentration averages for 2015 and 2016 were calculated for the pollutants of interest for each Arizona monitoring site, as described in Section 3.1. The *quarterly average concentration* of a particular pollutant is simply the average concentration of the preprocessed daily measurements over a given calendar quarter. Quarterly average concentrations include the substitution of zeros for all non-detects. A site must have a minimum of 75 percent valid samples compared to the total number of samples possible within a given calendar quarter for a quarterly average to be calculated. An *annual average concentration* includes all measured detections and substituted zeros for non-detects for an entire year of sampling. Annual averages were calculated for pollutants where three valid quarterly averages could be calculated for a given year and where method completeness was greater than or equal to 85 percent, as presented in Section 2.4. Quarterly and annual average concentrations for the pollutants of interest for the Arizona monitoring sites are presented in Table 5-3, where applicable. Note that concentrations of the PAHs and metals for PXSS are presented in ng/m^3 for ease of viewing. Also note that if a pollutant was not detected in a given calendar quarter, the quarterly average simply reflects "0" because only zeros substituted for non-detects were factored into the quarterly average concentration.

Table 5-3. Quarterly and Annual Average Concentrations of the Pollutants of Interest for the Arizona Monitoring Sites

Pollutant	2015						2016					
	# of Detects/ # >MDL/ # Samples	Q1 Avg (µg/m³)	Q2 Avg (µg/m³)	Q3 Avg (µg/m³)	Q4 Avg (µg/m³)	Annual Avg (µg/m³)	# of Detects/ # >MDL/ # Samples	Q1 Avg (µg/m³)	Q2 Avg (µg/m³)	Q3 Avg (µg/m³)	Q4 Avg (µg/m³)	Annual Avg (µg/m³)
Phoenix, Arizona - PXSS												
Acetaldehyde	33/33/33	NA	NA	NA	NA	NA	58/58/58	2.74 ± 0.64	2.66 ± 0.60	2.06 ± 0.28	3.47 ± 0.45	2.75 ± 0.28
Benzene	58/58/58	1.49 ± 0.50	0.56 ± 0.12	0.50 ± 0.14	1.62 ± 0.43	1.04 ± 0.21	60/60/60	1.40 ± 0.40	0.68 ± 0.18	0.62 ± 0.19	1.78 ± 0.39	1.13 ± 0.19
1,3-Butadiene	58/56/58	0.28 ± 0.12	0.09 ± 0.03	0.06 ± 0.02	0.35 ± 0.13	0.20 ± 0.05	60/52/60	0.32 ± 0.12	0.11 ± 0.03	0.08 ± 0.03	0.36 ± 0.10	0.22 ± 0.05
Carbon Tetrachloride	58/58/58	0.63 ± 0.03	0.61 ± 0.06	0.67 ± 0.03	0.59 ± 0.05	0.63 ± 0.02	60/60/60	0.60 ± 0.04	0.67 ± 0.04	0.56 ± 0.09	0.61 ± 0.04	0.61 ± 0.03
p-Dichlorobenzene	53/26/58	0.18 ± 0.06	0.11 ± 0.03	0.07 ± 0.03	0.24 ± 0.06	0.15 ± 0.03	59/40/60	0.19 ± 0.05	0.15 ± 0.04	0.15 ± 0.04	0.30 ± 0.08	0.20 ± 0.03
1,2-Dichloroethane	55/43/58	0.10 ± 0.03	0.08 ± 0.02	0.05 ± 0.01	0.10 ± 0.01	0.08 ± 0.01	55/55/60	0.11 ± 0.02	0.10 ± 0.01	0.05 ± 0.02	0.10 ± 0.01	0.09 ± 0.01
Ethylbenzene	58/58/58	0.69 ± 0.28	0.29 ± 0.08	0.31 ± 0.10	0.88 ± 0.26	0.54 ± 0.12	60/60/60	0.73 ± 0.23	0.39 ± 0.13	0.45 ± 0.13	1.02 ± 0.23	0.65 ± 0.11
Formaldehyde	33/33/33	NA	NA	NA	NA	NA	58/58/58	3.21 ± 0.57	4.34 ± 0.73	3.57 ± 0.32	4.17 ± 0.40	3.80 ± 0.27
Arsenic (PM_{10})[a]	59/58/59	0.55 ± 0.16	0.49 ± 0.16	0.46 ± 0.14	0.78 ± 0.21	0.57 ± 0.09	61/61/61	0.83 ± 0.50	0.44 ± 0.09	0.57 ± 0.25	1.01 ± 0.28	0.71 ± 0.16
Naphthalene[a]	55/55/55	69.06 ± 40.51	42.38 ± 10.11	NA	119.29 ± 25.43	74.36 ± 15.68	51/51/51	78.55 ± 19.41	NA	NA	109.73 ± 14.21	NA

[a] Average concentrations provided for the pollutants below the blue line are presented in ng/m³ for ease of viewing.
NA = Not available because the criteria for calculating a quarterly and/or annual average were not met.

Table 5-3. Quarterly and Annual Average Concentrations of the Pollutants of Interest for the Arizona Monitoring Sites (Continued)

Pollutant	2015						2016					
	# of Detects/ # >MDL/ # Samples	Q1 Avg (µg/m^3)	Q2 Avg (µg/m^3)	Q3 Avg (µg/m^3)	Q4 Avg (µg/m^3)	Annual Avg (µg/m^3)	# of Detects/ # >MDL/ # Samples	Q1 Avg (µg/m^3)	Q2 Avg (µg/m^3)	Q3 Avg (µg/m^3)	Q4 Avg (µg/m^3)	Annual Avg (µg/m^3)
South Phoenix, Arizona - SPAZ												
Benzene	32/32/32	1.92 ± 0.78	0.83 ± 0.35	0.64 ± 0.24	1.92 ± 0.64	1.28 ± 0.31	31/31/31	1.93 ± 0.74	0.81 ± 0.32	0.67 ± 0.31	1.82 ± 0.61	1.33 ± 0.32
1,3-Butadiene	32/31/32	0.35 ± 0.22	0.12 ± 0.05	0.10 ± 0.05	0.40 ± 0.19	0.23 ± 0.08	30/26/31	0.52 ± 0.29	0.13 ± 0.06	0.07 ± 0.04	0.35 ± 0.16	0.27 ± 0.10
Carbon Tetrachloride	32/32/32	0.59 ± 0.07	0.57 ± 0.03	0.63 ± 0.04	0.61 ± 0.05	0.60 ± 0.02	31/31/31	0.61 ± 0.04	0.67 ± 0.05	0.60 ± 0.07	0.61 ± 0.03	0.62 ± 0.02
p-Dichlorobenzene	32/21/32	0.27 ± 0.12	0.22 ± 0.11	0.17 ± 0.08	0.38 ± 0.12	0.25 ± 0.06	30/26/31	0.34 ± 0.07	0.25 ± 0.11	0.22 ± 0.14	0.40 ± 0.13	0.30 ± 0.06
1,2-Dichloroethane	30/24/32	0.08 ± 0.03	0.07 ± 0.03	0.05 ± 0.01	0.10 ± 0.02	0.07 ± 0.01	26/23/31	0.09 ± 0.01	0.09 ± 0.02	0.01 ± 0.02	0.09 ± 0.02	0.07 ± 0.01
Ethylbenzene	32/32/32	0.92 ± 0.43	0.42 ± 0.12	0.39 ± 0.18	0.96 ± 0.31	0.66 ± 0.15	31/31/31	0.88 ± 0.16	0.47 ± 0.22	0.54 ± 0.29	1.04 ± 0.33	0.74 ± 0.14

[a] Average concentrations provided for the pollutants below the blue line are presented in ng/m^3 for ease of viewing.
NA = Not available because the criteria for calculating a quarterly and/or annual average were not met.

Observations for PXSS from Table 5-3 include the following:

- The pollutants of interest with the highest annual average concentrations for PXSS for 2016 are formaldehyde (3.80 ± 0.27 µg/m^3), acetaldehyde (2.75 ± 0.28 µg/m^3), and benzene (1.13 ± 0.19 µg/m^3). For 2015, annual average concentrations could not be calculated for the carbonyl compounds due to a contamination issue that resulted in the invalidation of samples collected on the primary collection system between January and May and August and November. However, statistical summaries for 2015 are provided in Appendix M for the samples that were valid. For 2015, the pollutant of interest with the highest annual average concentrations for PXSS is benzene (1.04 ± 0.21 µg/m^3).

- A review of the quarterly average concentrations of benzene for PXSS shows that the first and fourth quarter average concentrations of benzene are significantly higher than the second and third quarter average concentrations, for both years. This indicates that there is a seasonal tendency in these measurements, with higher concentrations measured during the cooler months of the year. A similar observation was made in the 2013 and 2014 NMP reports. A review of the benzene data shows that all 18 benzene concentrations greater than 2 µg/m^3 were measured at PXSS between January and March or October and December of either year. Further, of the 52 benzene concentrations greater than 1 µg/m^3, 44 were measured during the first or fourth quarters of either year (19 during the first quarter and 25 during the fourth quarter).

- This trend can also be seen in the quarterly average concentrations of 1,3-butadiene and, to a lesser extent, *p*-dichlorobenzene and ethylbenzene. For 1,3-butadiene, 30 of the 31 highest concentrations, those greater than 0.25 µg/m^3, were measured during the first or fourth quarters of either year, with 14 measured at PXSS during the first quarters and 16 measured during the fourth quarters. All 15 concentrations greater than 0.5 µg/m^3 were measured in November, December, January, and February.

- Although the fourth quarter average concentration of acetaldehyde for 2016 is considerably higher than the next highest quarterly average shown, the confidence intervals for most of the quarterly averages indicate that there is considerable variability in the acetaldehyde measurements. Acetaldehyde concentrations measured at PXSS in 2016 vary by an order of magnitude, from 0.589 µg/m^3 to 5.83 µg/m^3, with a similar range if the 2015 data are included. Formaldehyde concentrations measured in 2016 exhibit considerable variability as well, ranging from 0.96 µg/m^3 to 7.24 µg/m^3. The minimum formaldehyde concentration measured in 2015 is similar to the minimum measured in 2016, but the maximum concentration measured in 2015 (18.3 µg/m^3) is among the highest formaldehyde concentrations measured across the program.

- Among the available quarterly average concentrations of naphthalene, the fourth quarter averages for both 2015 and 2016 are considerably higher than the other quarterly average shown, both greater than 100 ng/m^3. These quarterly averages and their associated confidence intervals indicate that there is considerable variability in the naphthalene concentrations measured at PXSS. Concentrations of naphthalene measured at PXSS range from 3.33 ng/m^3 to 213 ng/m^3. Several of the highest

naphthalene concentrations measured at PXSS were measured in November or December of either year, including 21 greater than 100 ng/m^3 (10 in 2015 and 11 in 2016), compared to 11 measured during the other 10 months of the years. An annual average concentration for 2016 could not be calculated for naphthalene because issues with the collection system resulting in the invalidation of samples collected during late summer and early fall led to low completeness. However, statistical summaries for 2016 are provided in Appendix N.

- Arsenic is the only metal pollutant of interest for PXSS. Arsenic concentrations measured at PXSS range from 0.08 ng/m^3 to 4.22 ng/m^3, with all five concentrations greater than 1.5 ng/m^3 measured in 2016. Three of these were measured during the fourth quarter of 2016, explaining (at least in part) the considerable differences in the quarterly average concentrations for 2016. The quarterly average concentrations for 2015 are less variable than the ones calculated for 2016.

Observations for SPAZ from Table 5-3 include the following:

- The pollutant of interest with the highest annual average concentrations for SPAZ is benzene (1.28 ± 0.31 µg/m^3, 2015, and 1.33 ± 0.32 µg/m^3, 2016). Benzene is the only pollutant of interest with an annual average concentration greater than 1 µg/m^3. Benzene concentrations measured at SPAZ range from 0.195 µg/m^3 to 4.19 µg/m^3.

- Similar to PXSS, benzene concentrations were highest during the first and fourth quarters of 2015 and 2016 at SPAZ, as indicated by the quarterly averages shown in Table 5-3. Nineteen of the 20 benzene concentrations greater than 1.5 µg/m^3 were measured during the first or fourth quarters of either year. Conversely, all but one of the 20 benzene concentrations less than 0.75 µg/m^3 were measured between April and September. The first and fourth quarter average concentrations of benzene for SPAZ are among the highest quarterly averages calculated across the program for this pollutant. However, the confidence intervals calculated for these averages also indicate that the concentrations measured are highly variable.

- The trend in the quarterly averages for benzene is also shown for 1,3-butadiene and ethylbenzene. All 22 1,3-butadiene concentrations greater than or equal to 0.25 µg/m^3 were measured at SPAZ during the first or fourth quarters of either year. Similarly, all but one of the 16 ethylbenzene concentrations greater than 1 µg/m^3 was measured at SPAZ during the first or fourth quarters of either year.

- Concentrations of carbon tetrachloride exhibit the least variability, with the quarterly average concentrations varying by approximately 0.1 µg/m^3.

- The fourth quarter 2016 average concentration of *p*-dichlorobenzene for SPAZ is the highest quarterly average concentration of this pollutant among sites sampling this pollutant. SPAZ's fourth quarter 2015 average concentration of *p*-dichlorobenzene ranks second highest. In fact, quarterly average concentrations of *p*-dichlorobenzene for SPAZ account for seven of the 12 quarterly averages greater than 0.2 µg/m^3 (i.e., only one quarterly average for SPAZ is less than 0.2 µg/m^3). Together, the Phoenix sites account for nine of the top 12 quarterly averages of this pollutant across the program.

Tables 4-10 through 4-13 present the NMP sites with the 10 highest annual average concentrations for each of the program-level pollutants of interest. Observations for PXSS and SPAZ from those tables include the following:

- PXSS and SPAZ appear in Tables 4-10 through 4-13 a total of 19 times.
- SPAZ and PXSS have the highest annual average concentrations (both years) of ethylbenzene among all NMP sites sampling VOCs. Although the highest individual ethylbenzene concentrations across the program were not measured at these sites, PXSS and SPAZ have the highest number of ethylbenzene concentrations greater than 1 $\mu g/m^3$ (20 and 16, respectively) among sites sampling this pollutant (the next highest site has seven).
- SPAZ also has the highest annual average concentrations (both years) of benzene and *p*-dichlorobenzene, and the second and third highest annual average concentrations (both years) of 1,3-butadiene (behind TVKY, 2015). The annual average concentrations for PXSS for these pollutants also appear in Table 4-10, but of varying ranks.
- PXSS's 2016 annual average concentration of acetaldehyde ranks third highest annual among NMP sites sampling carbonyl compounds. An annual average could not be calculated for 2015. PXSS's 2016 annual average concentration of formaldehyde ranks tenth highest.
- PXSS's annual average concentrations of the PAH pollutants of interest do not appear among the 10 highest annual average concentrations in Table 4-12. Annual averages could not be calculated for 2016. PXSS also does not appear in Table 4-13 for its annual average concentrations of arsenic.

5.3.2 Concentration Comparison

In order to better illustrate how each site's annual average concentrations compare to the program-level averages, a site-specific box plot was created for each of the site-specific pollutants of interest. Thus, box plots were created for each of the pollutants listed in Table 5-3 for PXSS and SPAZ. Figures 5-4 through 5-13 overlay the sites' minimum, annual average, and maximum concentrations for each year onto the program-level minimum, first quartile, median, average, third quartile, and maximum concentrations, as described in Section 3.4.2.1, and are discussed below. If an annual average concentration could not be calculated, the range of concentrations are still provided in the figures that follow.

Figure 5-4. Program vs. Site-Specific Average Acetaldehyde Concentrations

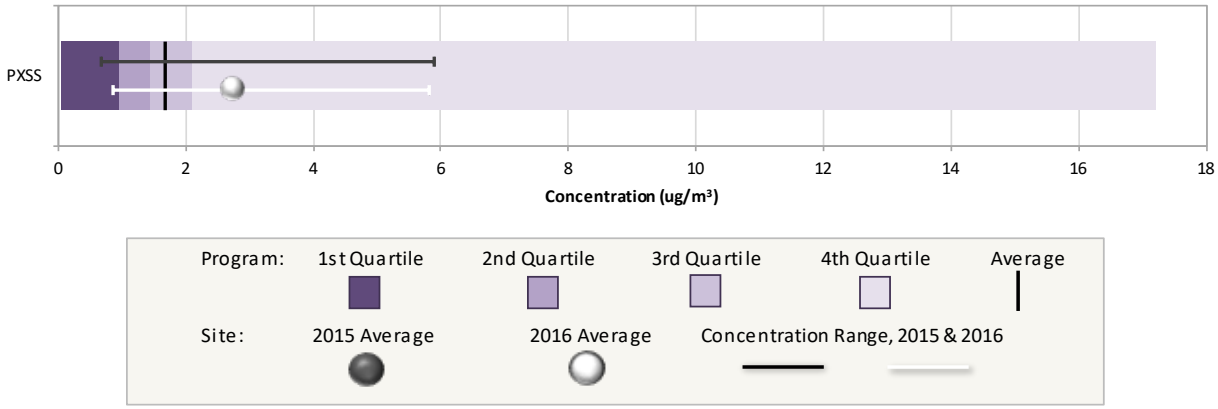


Figure 5-4 presents the box plot for acetaldehyde for PXSS and shows the following:

- While an annual average concentration could not be calculated for 2015, this figure shows that the range of concentrations measured was fairly consistent across the two years of sampling.

- PXSS's 2016 annual average concentration is greater than the program-level average concentration (1.67 µg/m^3) as well as the program-level third quartile (2.11 µg/m^3). PXSS has the third highest annual average acetaldehyde concentration among NMP sites sampling this pollutant and where annual average concentrations could be calculated. Acetaldehyde concentrations measured at PXSS span an order magnitude, ranging from 0.668 µg/m^3 to 5.89 µg/m^3.

Figure 5-5. Program vs. Site-Specific Average Arsenic (PM_{10}) Concentrations

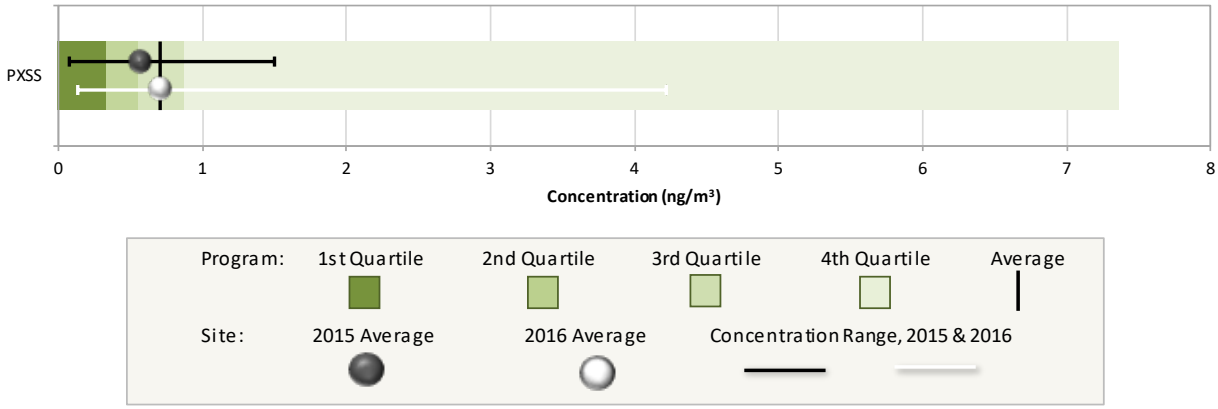


Figure 5-5 presents the box plot for arsenic for PXSS and shows the following:

- The maximum arsenic concentration measured at PXSS in 2016 is nearly three times higher than the maximum concentration measured in 2015, both of which are greater than the program-level third quartile.

- The annual average concentration of arsenic for 2016 is slightly higher than the annual average for 2015, both of which fall between the program-level median

(second quartile) and third quartile. The annual average for 2016 is similar to the program-level average concentration 0.70 ng/m^3.

Figure 5-6. Program vs. Site-Specific Average Benzene Concentrations

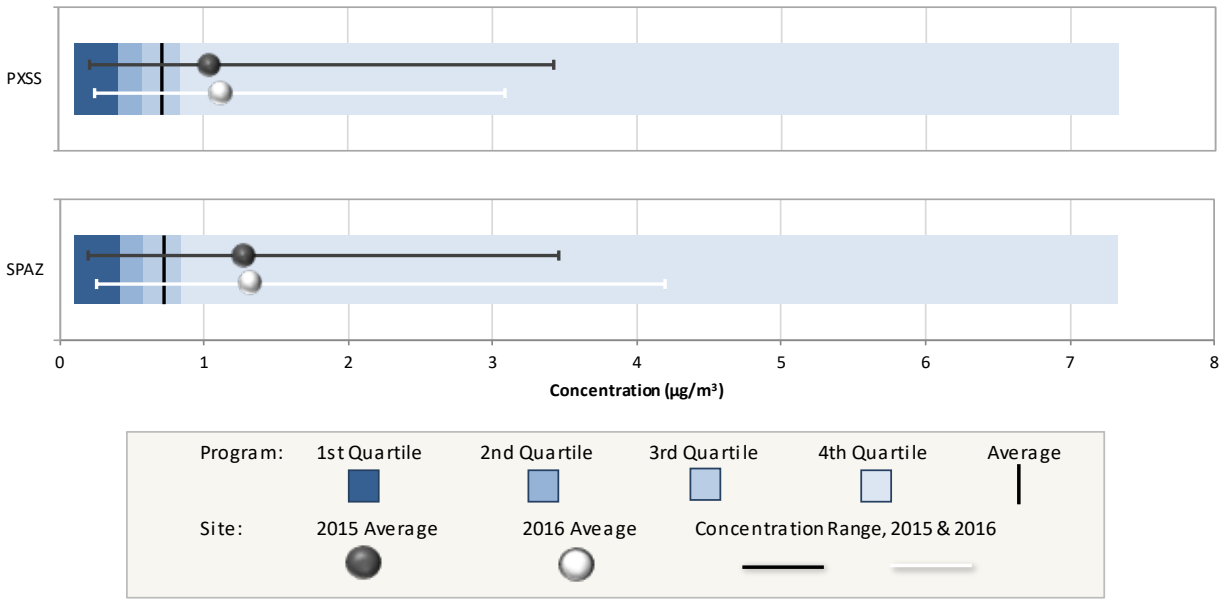


Figure 5-6 presents the box plots for benzene for both sites and shows the following:

- The range of benzene concentrations measured at PXSS in 2015 is similar to the range measured at SPAZ. For 2016, a few higher benzene concentrations were measured at SPAZ compared to PXSS.

- For both years, the annual average concentration for SPAZ is approximately 0.2 µg/m^3 greater than the annual averages for PXSS.

- Although the maximum benzene concentration measured at each Arizona site is considerably less than the maximum benzene concentration measured across the program, both sites' annual averages are greater than the program-level average concentration and third quartile. SPAZ has the highest annual average concentrations of benzene across the program, and PXSS's annual averages of benzene rank fifth (2016) and ninth (2015) among the NMP sites sampling this pollutant.

Figure 5-7. Program vs. Site-Specific Average 1,3-Butadiene Concentrations

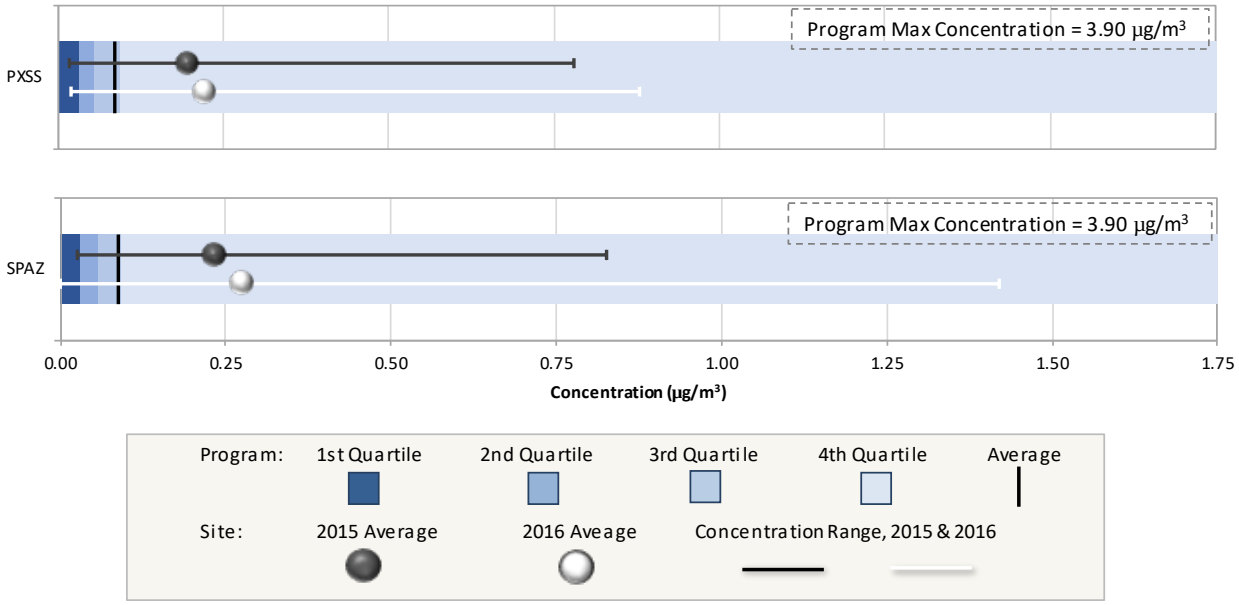


Figure 5-7 presents the box plots for 1,3-butadiene for both sites and shows the following:

- The program-level maximum 1,3-butadiene concentration (3.90 µg/m^3) is not shown directly on the box plots in Figure 5-7 because the scale of the box plots would be too large to readily observe data points at the lower end of the concentration range. Thus, the scale of the box plots has been reduced to 1.75 µg/m^3.

- The range of 1,3-butadiene concentrations measured at SPAZ in 2015 is fairly similar to the range measured at PXSS. For 2016, the concentration range for SPAZ appears considerably larger. This is due to a single non-detect on the low end of the concentration range and a single concentration greater than 1 µg/m^3 on the upper end of the range. If these two data points for SPAZ were excluded, the range of measurements for 2016 would be more similar between the two sites.

- The annual average concentrations for SPAZ are slightly higher than the annual average concentrations for PXSS, though not significantly so. The annual average concentrations for these two sites are each two to the three times greater than the program-level average concentrations (0.086 µg/m^3).

Figure 5-8. Program vs. Site-Specific Average Carbon Tetrachloride Concentrations

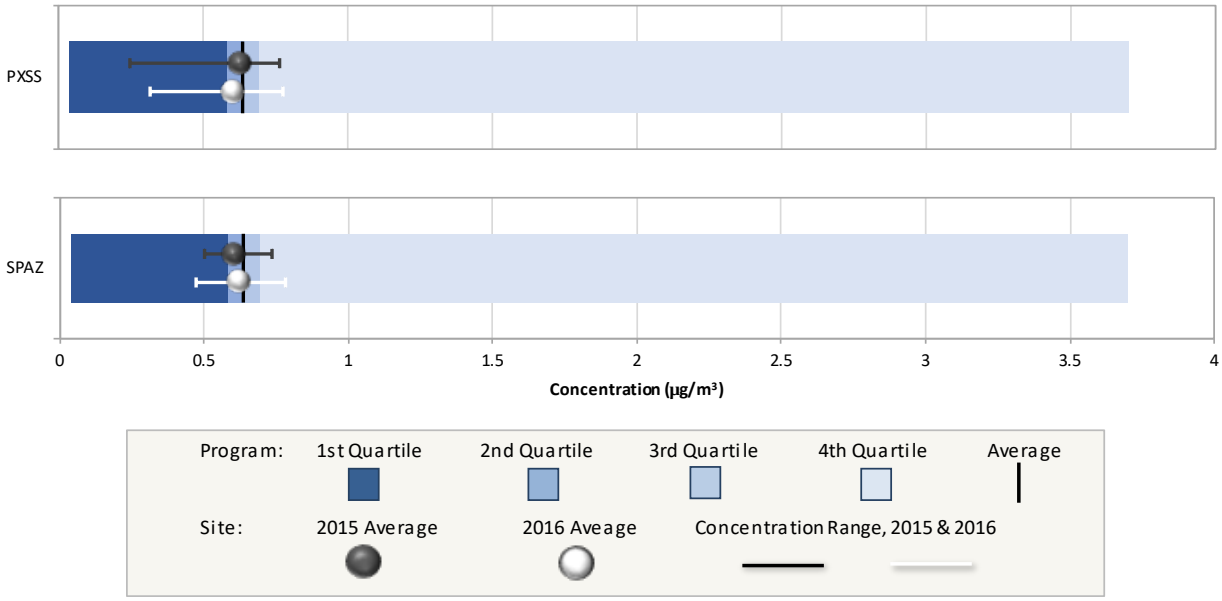


Figure 5-8 presents the box plots for carbon tetrachloride for both sites and shows the following:

- The program-level median (0.637 µg/m^3) and average (0.636 µg/m^3) concentrations for carbon tetrachloride are similar and plotted nearly on top of each other.
- The maximum carbon tetrachloride concentrations measured at these sites are similar to each other, while the minimum concentrations are more variable. Nine concentrations measured at PXSS are less than the minimum concentration measured at SPAZ.
- The annual average concentrations of carbon tetrachloride for the Arizona sites are similar to each other, all four of which are just less than the program-level average concentration.

Figure 5-9. Program vs. Site-Specific Average *p*-Dichlorobenzene Concentrations

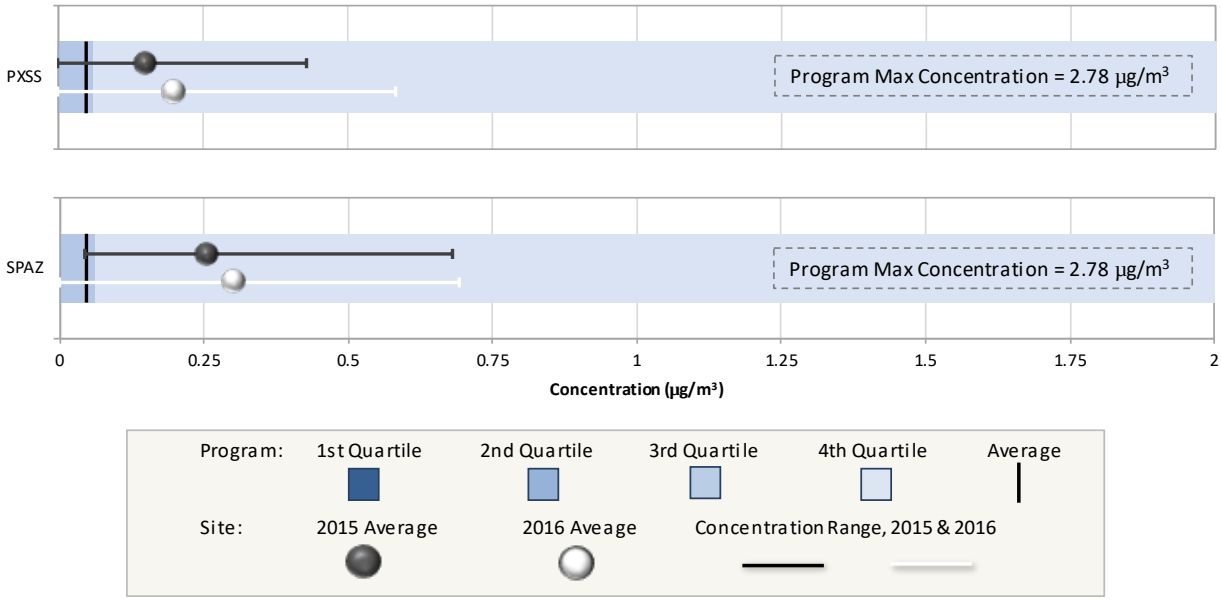


Figure 5-9 presents the box plots for *p*-dichlorobenzene for both sites and shows the following:

- The program-level maximum *p*-dichlorobenzene concentration (2.78 µg/m^3) is not shown directly on the box plots in Figure 5-9 because the scale of the box plots would be too large to readily observe data points at the lower end of the concentration range. Thus, the scale of the box plots has been reduced. The program-level first and second quartiles are both zero for *p*-dichlorobenzene and therefore not visible on the box plots.

- The range of *p*-dichlorobenzene concentrations measured at SPAZ is larger than the range measured at PXSS, though the maximum concentrations for both sites are considerably less than the maximum concentration measured across the program. However, the maximum concentrations measured at SPAZ and PXSS are still among some of the highest measured across the program.

- SPAZ has the two highest annual average concentrations of *p*-dichlorobenzene among the NMP sites sampling VOCs; PXSS has the fourth and fifth highest annual average concentrations of this pollutant. The annual average concentrations for SPAZ and PXSS are several times greater than the program-level average concentration (0.047 µg/m^3).

- Six non-detects of *p*-dichlorobenzene were measured at PXSS over the two years of sampling while a single non-detect was measured at SPAZ.

Figure 5-10. Program vs. Site-Specific Average 1,2-Dichloroethane Concentrations

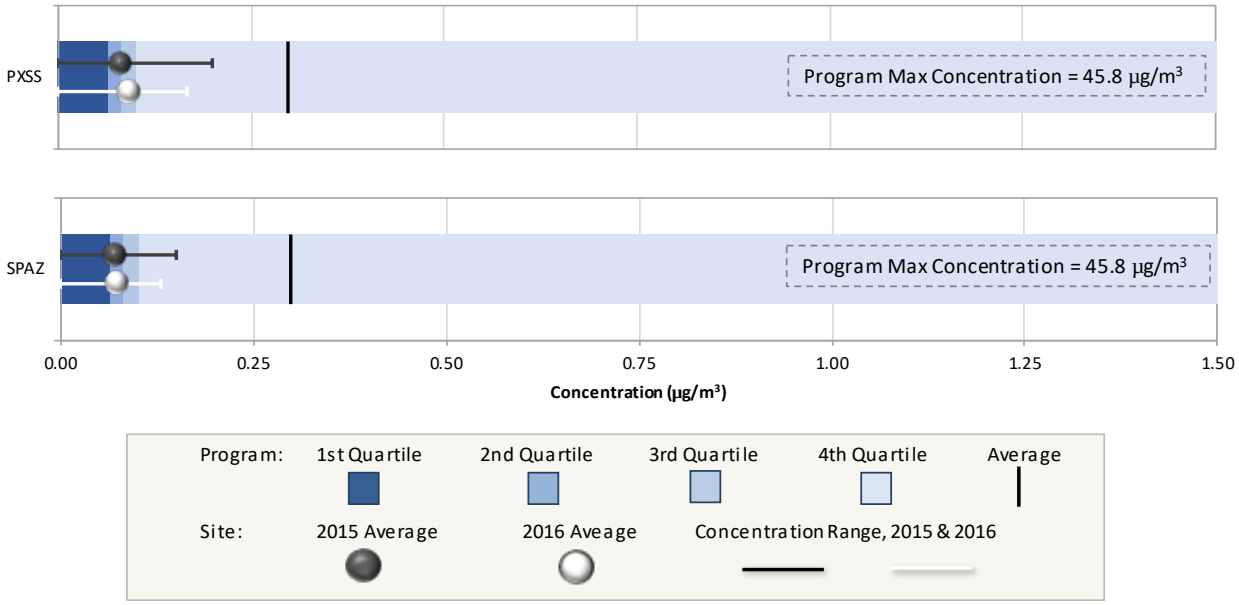


Figure 5-10 presents the box plots for 1,2-dichloroethane for both sites and shows the following:

- The scale of the box plots in Figure 5-10 has also been reduced to allow for the observation of data points at the lower end of the concentration range, as the program-level maximum 1,2-dichloroethane concentration (45.8 µg/m^3) is considerably greater than the majority of measurements.

- All of the concentrations of 1,2-dichloroethane measured at PXSS and SPAZ are less than the program-level average concentration of 0.30 µg/m^3, which is being driven by the measurements at the upper end of the concentration range.

- Each of the annual average concentrations for PXSS and SPAZ is less than 0.1 µg/m^3, and three of the four annual averages are less than the program-level median concentration (0.081 µg/m^3).

Figure 5-11. Program vs. Site-Specific Average Ethylbenzene Concentrations

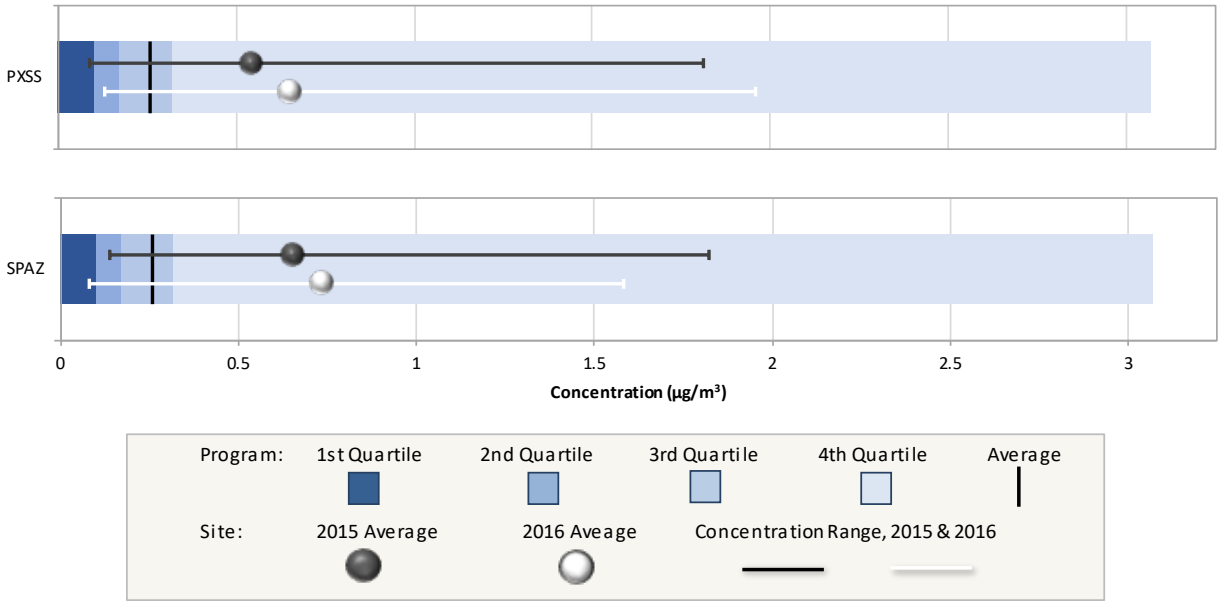


Figure 5-11 presents the box plots for ethylbenzene for both sites and shows the following:

- The range of ethylbenzene concentrations measured at SPAZ in 2015 is similar to the range of ethylbenzene concentrations measured at PXSS for 2015. For 2016, a few higher ethylbenzene concentrations were measured at PXSS compared to SPAZ. Together, PXSS (20) and SPAZ (16) have the highest number of ethylbenzene concentrations greater than 1 µg/m^3 among NMP sites sampling this pollutant (the next highest is seven).

- The annual average concentrations of ethylbenzene for these two sites are two to three times greater than the program-level average. These sites have the highest annual average concentrations of ethylbenzene among NMP sites sampling this pollutant.

Figure 5-12. Program vs. Site-Specific Average Formaldehyde Concentrations

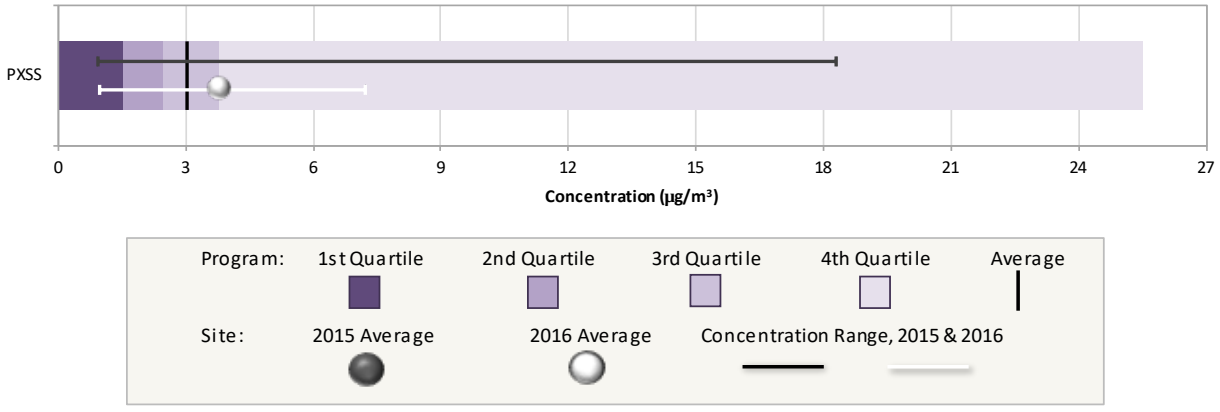


Figure 5-12 presents the box plot for formaldehyde for PXSS and shows the following:

- The minimum formaldehyde concentration measured at PXSS in 2015 is similar to the minimum measured in 2016. This is not true for the maximum concentration. Despite the limited number of valid samples for 2015, the maximum concentration measured in 2015 is two and half times greater than the maximum concentration measured in 2016. PXSS is one of only six sites where a formaldehyde concentration greater than 15 µg/m^3 was measured (though there is only one).

- The annual average concentration of formaldehyde for 2016 is greater than the program-level average concentration and similar to the program-level third quartile. PXSS has the tenth highest annual average concentration of formaldehyde among NMP sites sampling carbonyl compounds.

Figure 5-13. Program vs. Site-Specific Average Naphthalene Concentrations

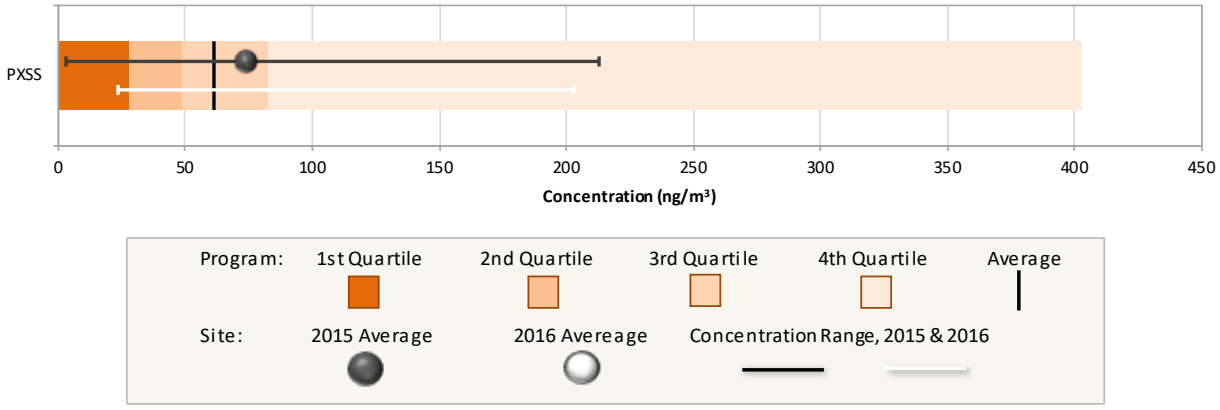


Figure 5-13 presents the box plot for naphthalene for PXSS and shows the following:

- The range of naphthalene concentrations measured at PXSS in 2015 is somewhat larger than the range of concentrations measured in 2016. There is a considerable difference in the minimum concentrations measured each year (3.33 ng/m^3 for 2015 and 23.5 ng/m^3 for 2016). PXSS is one of only five NMP sites with an individual naphthalene concentration less than 5 ng/m^3. A number of samples with consistently low measurements was collected at PXSS during March 2015.

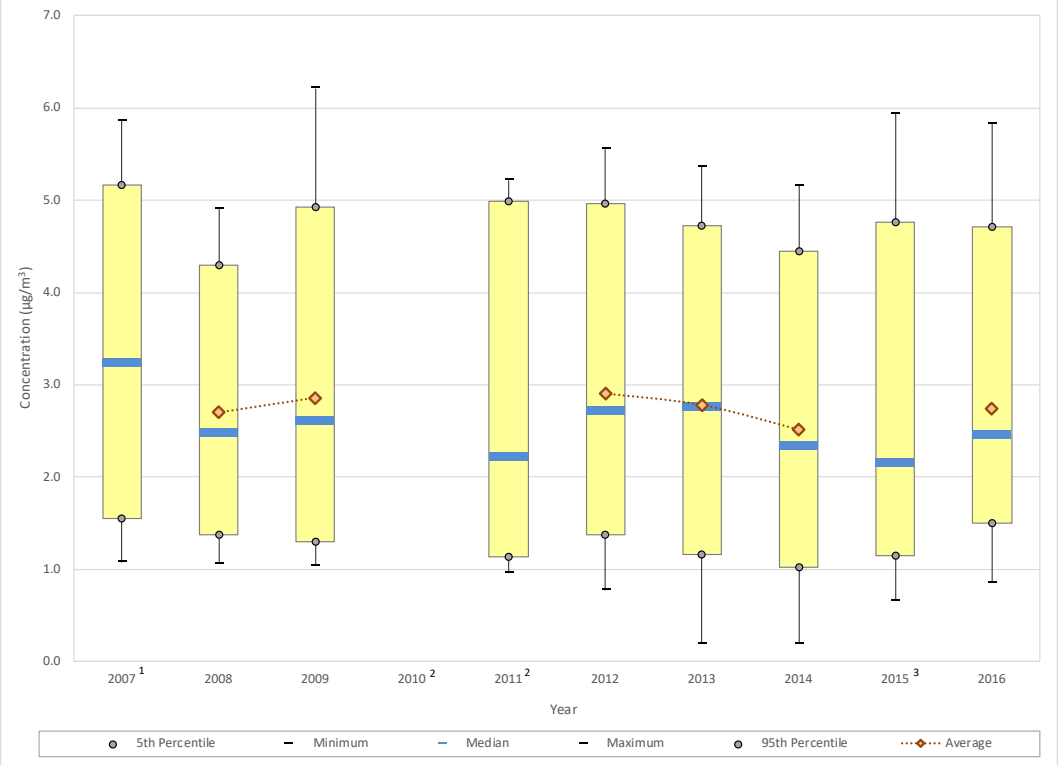
- The annual average naphthalene concentration for PXSS for 2015 falls between the program-level average concentration (61.23 ng/m^3) and the program-level third quartile (82.15 ng/m^3). An annual average concentration could not be calculated for 2016 because the completeness criteria was not met.

5.3.3 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the pollutants of interest for 5 consecutive years or longer, as described in Section 3.4.2.2. PXSS has sampled PM_{10} metals under the NMP since 2006; in addition, SPAZ began sampling VOCs and PXSS began sampling VOCs, carbonyl compounds, and PAHs under the NMP in

2007. Thus, Figures 5-14 through 5-29 present the 1-year statistical metrics for each of the pollutants of interest first for PXSS, then for SPAZ. The statistical metrics presented for assessing trends include the substitution of zeros for non-detects. If sampling began mid-year, a minimum of 6 months of sampling is required for inclusion in the trends analysis; in these cases, a 1-year average concentration is not provided, although the range and percentiles are still presented.

Figure 5-14. Yearly Statistical Metrics for Acetaldehyde Concentrations Measured at PXSS



[1] A 1-year average is not presented because sampling under the NMP did not begin until July 2007.
[2] Some statistical metrics are not presented because data from Feb 2010 to Mar 2011 was invalidated.
[3] A 1-year average is not presented due to a contamination issue affecting numerous samples.

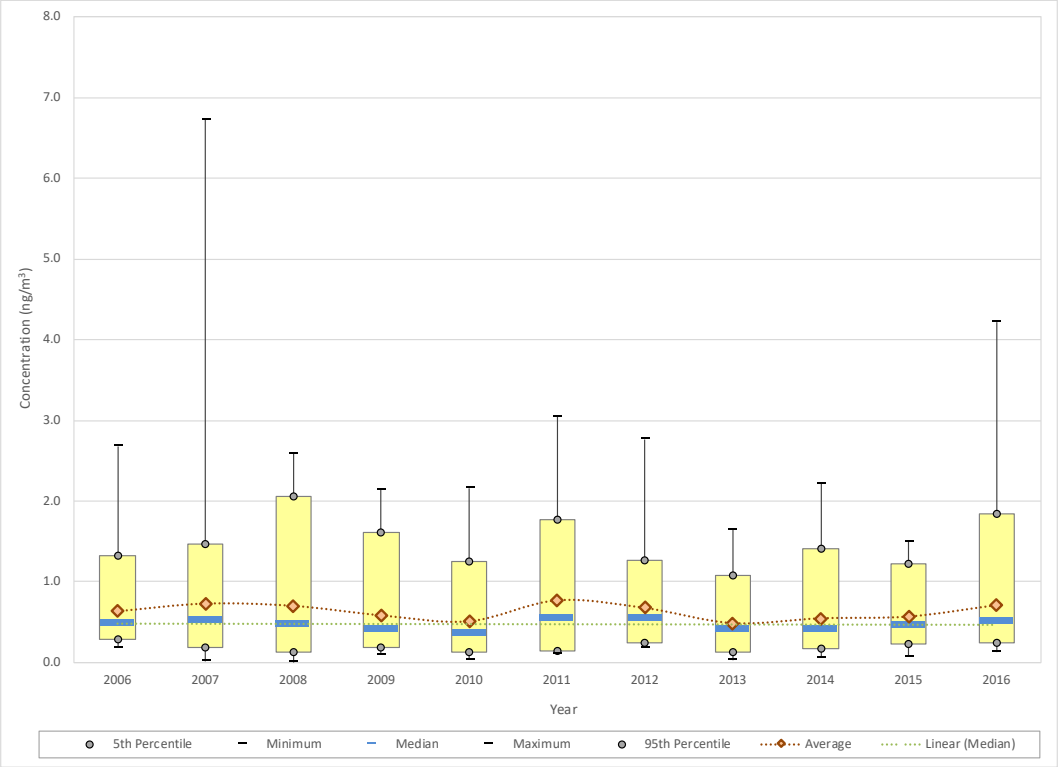
Observations from Figure 5-14 for acetaldehyde concentrations measured at PXSS include the following:

- PXSS began sampling acetaldehyde under the NMP in July 2007. Because a full year's worth of data is not available, a 1-year average concentration for 2007 is not presented, although the range of measurements is provided. In addition, much of the data between February 2010 and March 2011 was invalidated due to maintenance issues on the primary collection system. No statistical metrics are provided for 2010 due to the low number of valid measurements. The range of measurements is provided for 2011, although a 1-year average is not provided. Similarly, no 1-year average is provided for 2015.

- The maximum acetaldehyde concentration (6.21 µg/m^3) was measured on January 1, 2009, although this measurement is not significantly higher than maximum concentrations measured in other years. Acetaldehyde concentrations greater than 5 µg/m^3 have been measured every year except 2008 (and 2010, for which no data is provided).

- A distinct trend is hard to identify because several 1-year average concentrations could not be calculated. However, the 1-year averages shown vary by less than 0.4 µg/m^3, ranging from 2.52 µg/m^3 (2014) to 2.90 µg/m^3 (2012). The median concentrations exhibit more variability, ranging from 2.17 µg/m^3 (2015) to 3.24 µg/m^3 (2007).

Figure 5-15. Yearly Statistical Metrics for Arsenic (PM_{10}) Concentrations Measured at PXSS



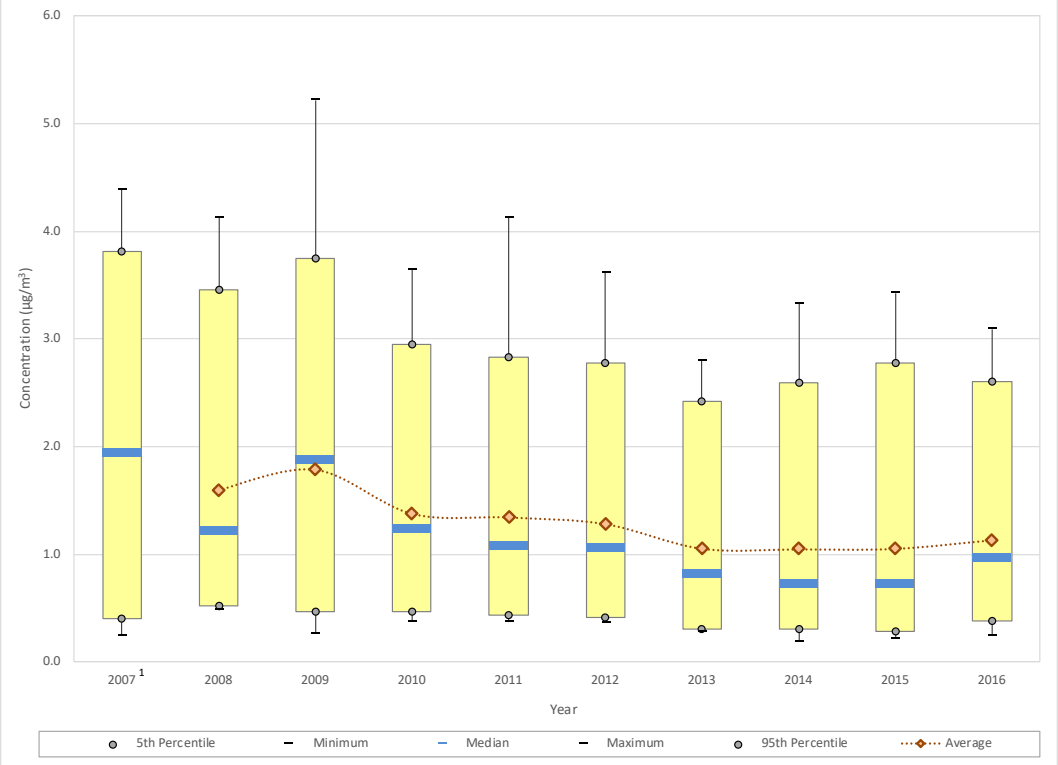
Observations from Figure 5-15 for arsenic concentrations measured at PXSS include the following:

- The maximum arsenic concentration (6.73 ng/m^3) was measured on December 26, 2007. The second highest concentration was measured on January 1, 2016 (4.22 ng/m^3). Only one additional concentration greater than 3 ng/m^3 has been measured at PXSS (3.05 ng/m^3, 2011). In total, 18 arsenic measurements greater than or equal to 2 ng/m^3 have been measured at PXSS, with at least one measured each year of sampling except 2013 and 2015.

- After several years of decreasing slightly, the 1-year average concentration increased significantly from 2010 to 2011, after which additional decreasing is shown through

2013. The 1-year average concentration is at a minimum for 2013 (0.49 ng/m^3). The 1-year average increases slightly each year following 2013, even for 2015, when the smallest range of concentrations was measured.

Figure 5-16. Yearly Statistical Metrics for Benzene Concentrations Measured at PXSS



[1] A 1-year average is not presented because sampling under the NMP did not begin until July 2007.

Observations from Figure 5-16 for benzene concentrations measured at PXSS include the following:

- PXSS began sampling VOCs under the NMP in July 2007. Because a full year's worth of data is not available, a 1-year average concentration for 2007 is not presented, although the range of measurements is provided.

- The maximum benzene concentration shown was measured on January 1, 2009 (5.22 µg/m^3), the same day the maximum acetaldehyde concentration was measured. Four additional measurements greater than 4 µg/m^3 have been measured at this site (one measured each year during 2007, 2008, 2009, and 2011).

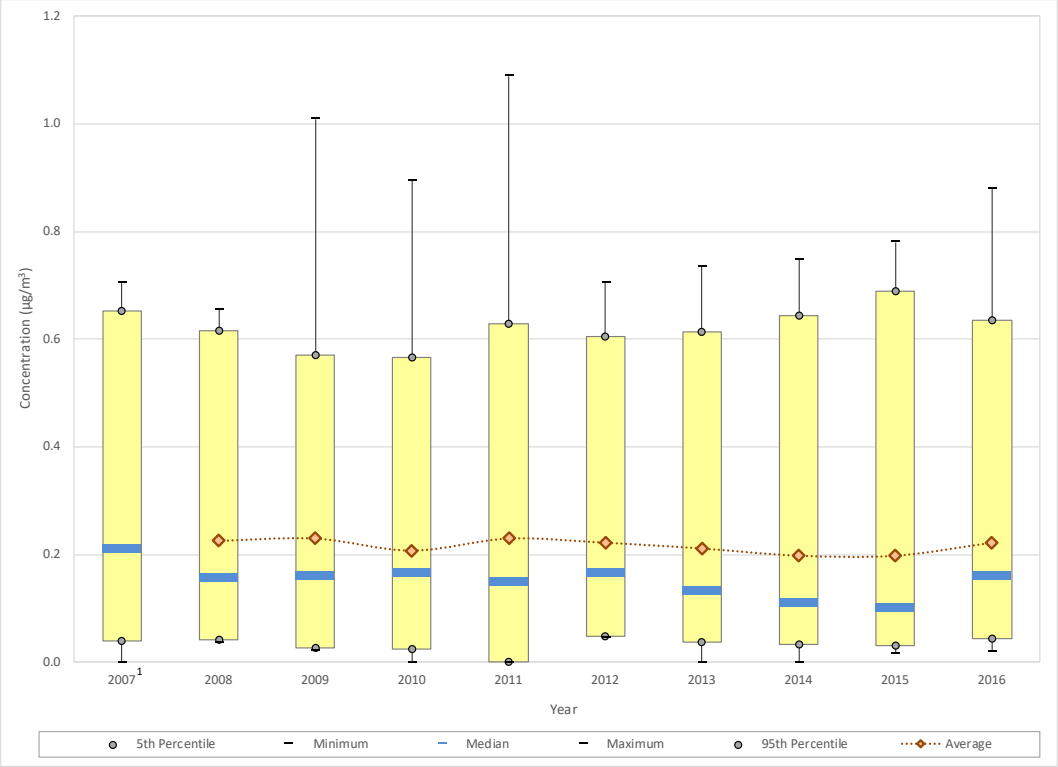
- All but one of the 36 highest benzene concentrations (those greater than 3.0 µg/m^3) were measured during the first or fourth quarter of any given year (and the exception was measured in late September). Further, of the 128 benzene concentrations greater than or equal to 2 µg/m^3, all but 10 were measured during the first or fourth quarters of a given year; those other 10 were all measured in either April or September, or just outside the first or fourth calendar quarters.

- The median concentration increased significantly from 2008 to 2009 and is greater than the 1-year average concentration for 2009. A review of the data shows that the number of concentrations greater than 2 µg/m^3 increased from 15 in 2008 to 24 in 2009. After the increase from 2008 to 2009, the median benzene concentration has a decreasing trend through 2015, and is at a minimum for 2014 and 2015 (both at 0.74 µg/m^3). The number of benzene concentrations greater than 2 µg/m^3 decreased to 12 in 2010, with the number ranging from eight (2015) to 14 (2011) for each of the remaining years.

- The 1-year average concentration exhibits a similar pattern as the median concentration, with the 1-year average concentration (1.05 µg/m^3) at a minimum for 2014, although there is relatively little change between 2013 and 2015.

- Despite having one of the smallest range of concentrations measured, the 1-year average and median concentrations for 2016 both exhibit increases. For the 1-year average, the increase is slight (less than 0.1 µg/m^3) while the median concentration is approaching 1 µg/m^3 for the first time since 2012.

Figure 5-17. Yearly Statistical Metrics for 1,3-Butadiene Concentrations Measured at PXSS



[1] A 1-year average is not presented because sampling under the NMP did not begin until July 2007.

Observations from Figure 5-17 for 1,3-butadiene concentrations measured at PXSS include the following:

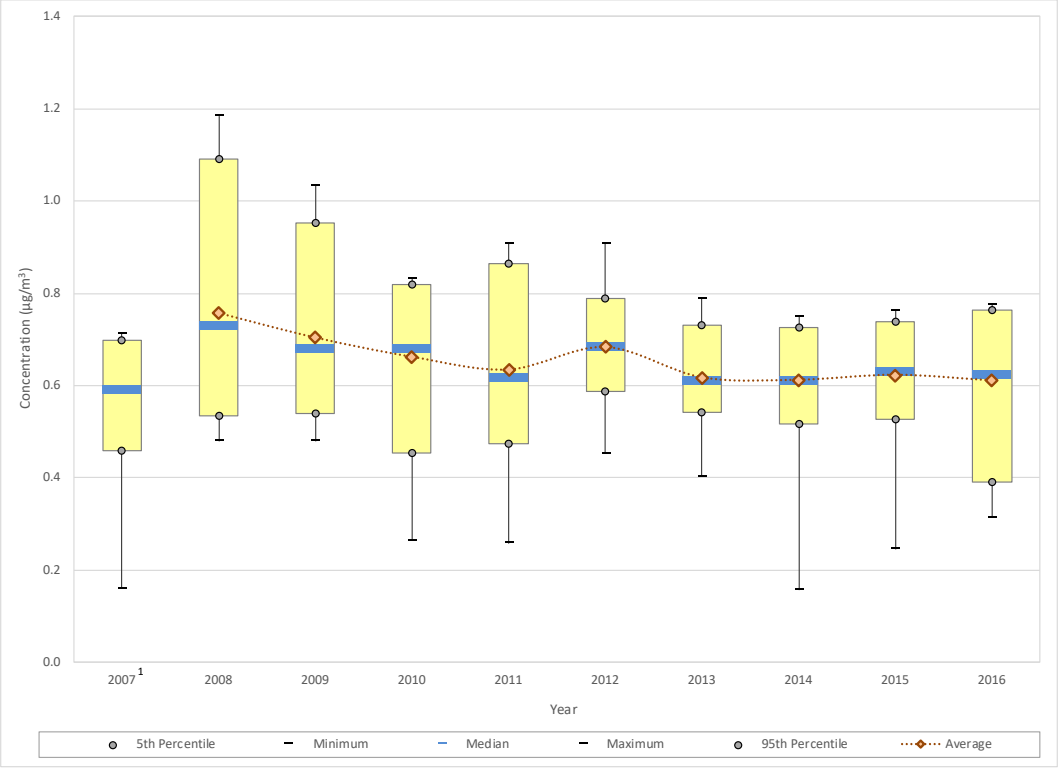
- The maximum 1,3-butadiene concentration (1.09 µg/m^3) was measured on December 11, 2011. The only other concentration greater than 1.0 µg/m^3 was measured at PXSS on January 1, 2009, the same day that the maximum benzene and acetaldehyde concentrations were measured.

- All but one of the 138 1,3-butadiene concentrations greater than 0.30 µg/m^3 were measured during the first or fourth quarters. The one concentration not measured during the first or fourth quarters was measured in September.

- The 1-year average 1,3-butadiene concentration exhibits relatively little change over the period shown, ranging from 0.20 µg/m^3 (both 2014 and 2015) to 0.23 µg/m^3 (both 2009 and 2011). The median concentration ranges from 0.10 µg/m^3 (2015) to 0.21 µg/m^3 (2007).

- The minimum concentrations, and in one case the 5th percentile, for several years are zero, indicating the substitution of zeros for non-detects. Ten non-detects of 1,3-butadiene have been measured at PXSS since the onset of VOC sampling at PXSS under the NMP. Five of these were measured in 2011, with one each measured in 2007, 2013, and 2014, and two measured in 2010. Non-detects were not measured in 2008, 2009, 2012, 2015, or 2016.

Figure 5-18. Yearly Statistical Metrics for Carbon Tetrachloride Concentrations Measured at PXSS



[1] A 1-year average is not presented because sampling under the NMP did not begin until July 2007.

Observations from Figure 5-18 for carbon tetrachloride concentrations measured at PXSS include the following:

- Seven concentrations of carbon tetrachloride greater than 1.0 µg/m^3 have been measured at PXSS since the onset of sampling in 2007, with five measured in 2008 and two measured in 2009.

- The box and whisker plots for 2007, 2010, 2011, 2014, and 2015 appear "inverted," with the minimum concentration extending farther away from the majority of the measurements rather than the maximum concentration, which is more common (see benzene or 1,3-butadiene as examples).

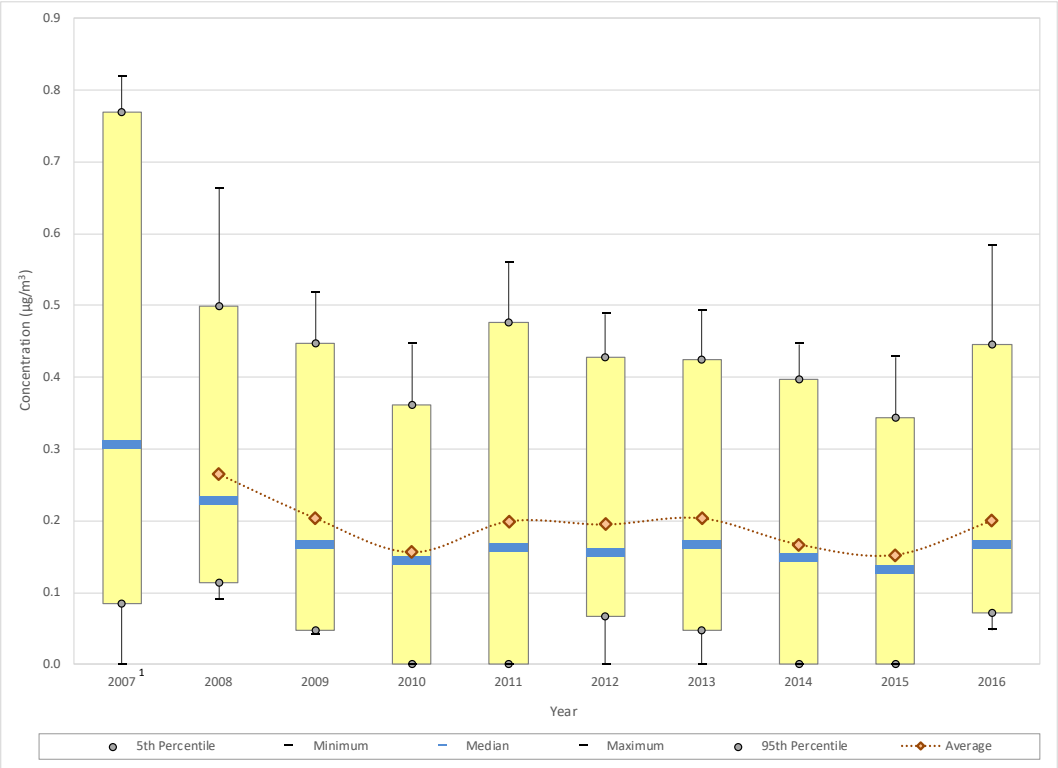
- All of the carbon tetrachloride concentrations measured in 2007 are less than the 1-year average and median concentrations calculated for 2008. However, the concentrations measured in 2007 represent only one-half of the year.

- The 1-year average concentration exhibits a decreasing trend between 2008 and 2011. Although the range of concentrations measured decreased for 2012, an increase is shown for the 1-year average and median concentrations for 2012. This is mostly a result of a change at the lower end of the concentration range. The number of concentrations less than 0.6 µg/m^3 measured in 2011 is 23; the number of concentrations less than 0.6 µg/m^3 measured in 2012 is five.

- All of the statistical parameters for carbon tetrachloride exhibit a decrease for 2013. The majority of concentrations fall into a similar range between 2013 and 2015, as little change is shown in most of the statistical parameters during this period.

- The 5th percentile for 2016 exhibits a considerable decrease compared to the 5th percentiles for several of the previous years, and is at a minimum for the period of sampling. This year has more carbon tetrachloride measurements less than 0.4 µg/m^3 (four) than any other year of sampling (prior to 2015, no other year has more than one carbon tetrachloride concentration less than 0.4 µg/m^3; 2015 has two and 2016 has four).

Figure 5-19. Yearly Statistical Metrics for *p*-Dichlorobenzene Concentrations Measured at PXSS



[1] A 1-year average is not presented because sampling under the NMP did not begin until July 2007.

Observations from Figure 5-19 for *p*-dichlorobenzene concentrations measured at PXSS include the following:

- The three highest concentrations of *p*-dichlorobenzene were all measured in November 2007 and are the only ones greater than 0.75 µg/m^3 measured at PXSS.

- The maximum, 95th percentile, 1-year average, and median concentrations all exhibit a significant decreasing trend through 2010. The minimum concentration and 5th percentile also decreased each year between 2008 and 2010.

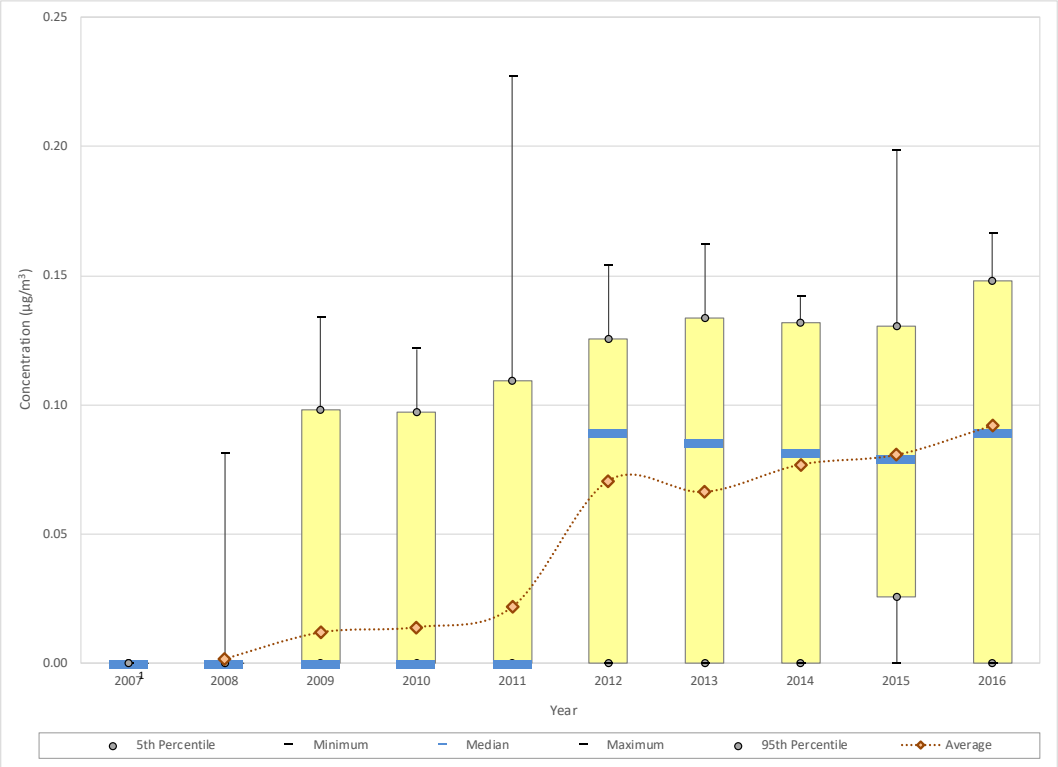
- Each of the statistical parameters increased from 2010 to 2011, with the exceptions of the minimum and 5th percentile, as several non-detects were measured in both years. Although the range within which the majority of the concentrations fall tightened up for 2012 and 2013, little change is shown for the 1-year average or median concentrations between 2011 and 2013.

- Each of the statistical parameters decreased at least slightly for 2014, except the minimum concentration, which has remained constant since 2010. Additional decreases in most of the statistical parameters are shown for 2015, with the minimum and 5th percentile remaining unchanged.

- All of the statistical parameters exhibit increases for 2016, including the minimum concentration, which is greater than zero for the first time since 2009.

- The number of non-detects has varied between none (several years) and nine (2010).

Figure 5-20. Yearly Statistical Metrics for 1,2-Dichloroethane Concentrations Measured at PXSS



[1] A 1-year average is not presented because sampling under the NMP did not begin until July 2007.

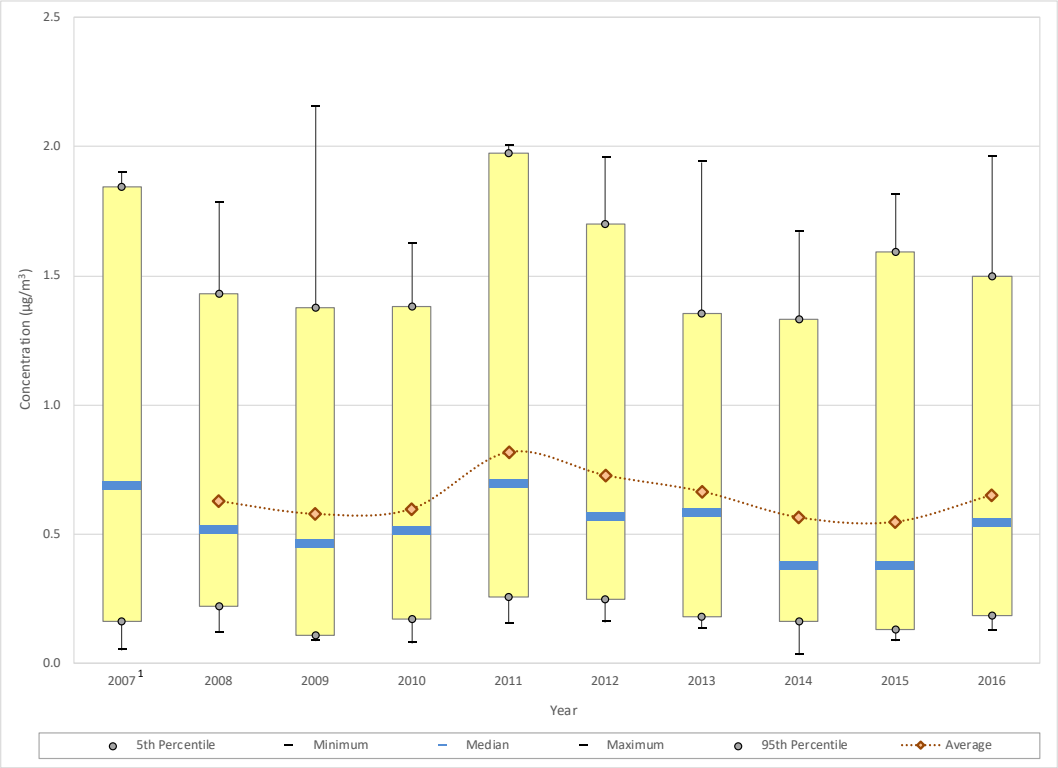
Observations from Figure 5-20 for 1,2-dichloroethane concentrations measured at PXSS include the following:

- There were no measured detections of 1,2-dichloroethane in 2007. The number increased gradually each year through 2011 (12), then significantly for 2012 (47), with more than 50 measured detections in each of the last three years.

- The median concentration is zero for each year through 2011, indicating that at least 50 percent of the measurements were non-detects for the first 5 years of sampling.

- The number of measured detections increased markedly for 2012, and the median and 1-year average concentrations increased correspondingly. The median concentration is greater than the 1-year average concentration for each year between 2012 and 2014. This is because there were still many non-detects (or zeros) factoring into the 1-year average concentration for 2012 (14), 2013 (23), and 2014 (8), which pull the 1-year average concentrations down in the same manner that a maximum or outlier concentration can drive the average up. The number of measured detections exceeds 90 percent for 2015 and 2016, and the 1-year average concentration for these two years is greater than the median concentration.

Figure 5-21. Yearly Statistical Metrics for Ethylbenzene Concentrations Measured at PXSS



[1] A 1-year average is not presented because sampling under the NMP did not begin until July 2007.

Observations from Figure 5-21 for ethylbenzene concentrations measured at PXSS include the following:

- The maximum concentration of ethylbenzene measured at PXSS (2.16 µg/m^3) was measured on January 1, 2009, the same day that the maximum concentrations of several pollutants were measured at this site. The next four highest concentrations were all measured in November 2011, including the only other concentration greater than 2 µg/m^3 measured at PXSS (2.01 µg/m^3).

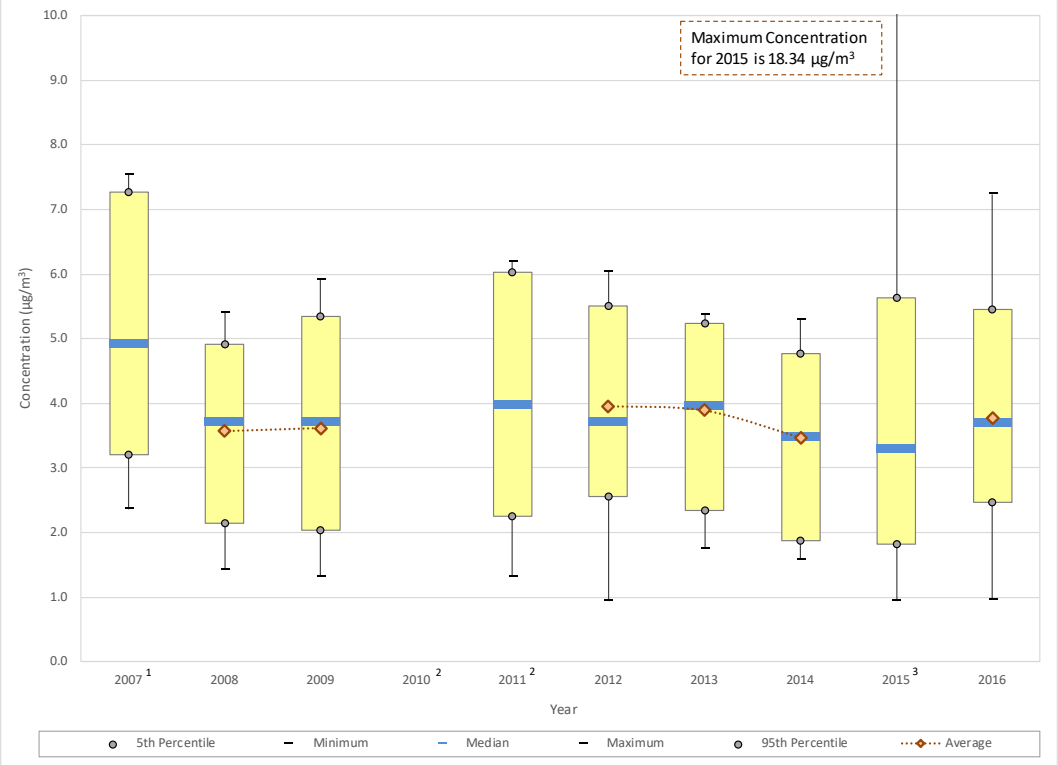
- Similar to benzene and 1,3-butadiene, the highest ethylbenzene concentrations were measured most often during the first and fourth quarters of the years. Of the 119 highest concentrations of ethylbenzene (those greater than 1.0 µg/m^3), 108 were measured between January and March or October and December of any given year.

- The median ethylbenzene concentration decreases each year through 2009, then returns to 2008 levels for 2010, and returns to 2007 levels for 2011. All of the statistical parameters shown increased from 2010 to 2011. Nearly twice the number of concentrations greater than 1 µg/m^3 were measured in 2011 (20) than in each the previous years, which vary between nine (2008) and 11 (both 2007 and 2010).

- A significant decreasing trend in the 1-year average concentration is shown between 2011 and 2015, with the 1-year average concentration at a minimum for 2015 (0.55 µg/m^3). The median concentration is at a minimum for 2014 and 2015 (0.38 µg/m^3).

- All of the statistical parameters except the 95th percentile exhibit an increase for 2016, with the concentration profile for 2016 resembling the concentration profile for 2013. The number of ethylbenzene concentrations between 0.5 µg/m^3 and 1.5 µg/m^3 measured nearly doubled between 2015 (17) and 2016 (31).

Figure 5-22. Yearly Statistical Metrics for Formaldehyde Concentrations Measured at PXSS



[1] A 1-year average is not presented because sampling under the NMP did not begin until July 2007.
[2] Some statistical metrics are not presented because data from Feb 2010 to Mar 2011 was invalidated.
[3] A 1-year average is not presented due to a contamination issue affecting numerous samples.

Observations from Figure 5-22 for formaldehyde concentrations measured at PXSS include the following:

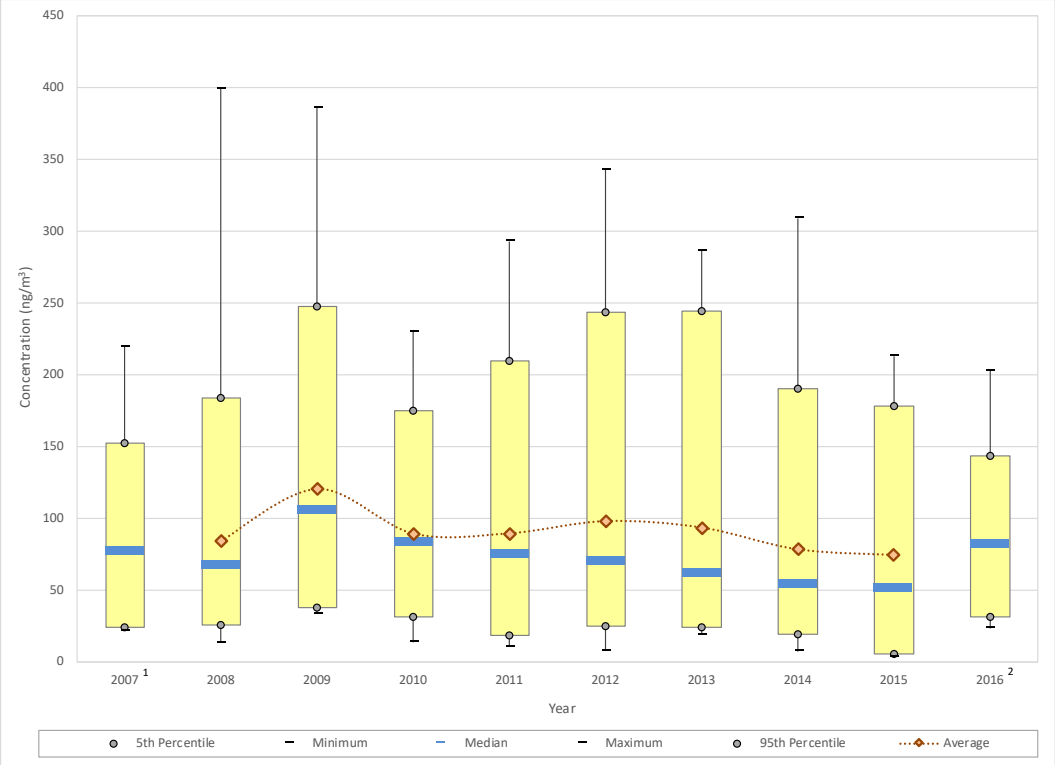
- PXSS began sampling formaldehyde under the NMP in July 2007. Because a full year's worth of data is not available, a 1-year average concentration for 2007 is not presented, although the range of measurements is provided. In addition, much of the data between February 2010 and March 2011 was invalidated due to maintenance issues on the primary collection system. No statistical metrics are provided for 2010 due to the low number of valid measurements. The range of measurements is provided for 2011, although a 1-year average is not provided. Similarly, no 1-year average is provided for 2015.

- The maximum formaldehyde concentration was measured at PXSS on November 26, 2015 (18.34 µg/m^3) and is more than twice the next highest formaldehyde concentration (7.56 µg/m^3). The only formaldehyde concentrations greater than 7 µg/m^3 were measured in either 2007 (3), 2015 (1), and 2016 (1).

- The median concentration for 2007 is nearly 5 µg/m^3 (the median concentrations for all of the years that follow are all less than 4 µg/m^3) and is greater than the 95th percentile for two of the years of sampling (2008 and 2014).

- Even though the maximum concentration measured in 2015 is considerably higher than any other formaldehyde concentrations measured since the onset of sampling, the median concentration (3.30 µg/m^3) is at a minimum for 2015. It is important to note that a large number of carbonyl compound samples collected in 2015 were invalidated due to contamination issues with the primary collection system. Only about half of the samples for 2015 were retained after the contamination issue was resolved.

Figure 5-23. Yearly Statistical Metrics for Naphthalene Concentrations Measured at PXSS



[1] A 1-year average is not presented because sampling under the NMP did not begin until July 2007.
[2] A 1-year average is not presented due to collection system issues affecting many samples collected in 2016.

Observations from Figure 5-23 for naphthalene concentrations measured at PXSS include the following:

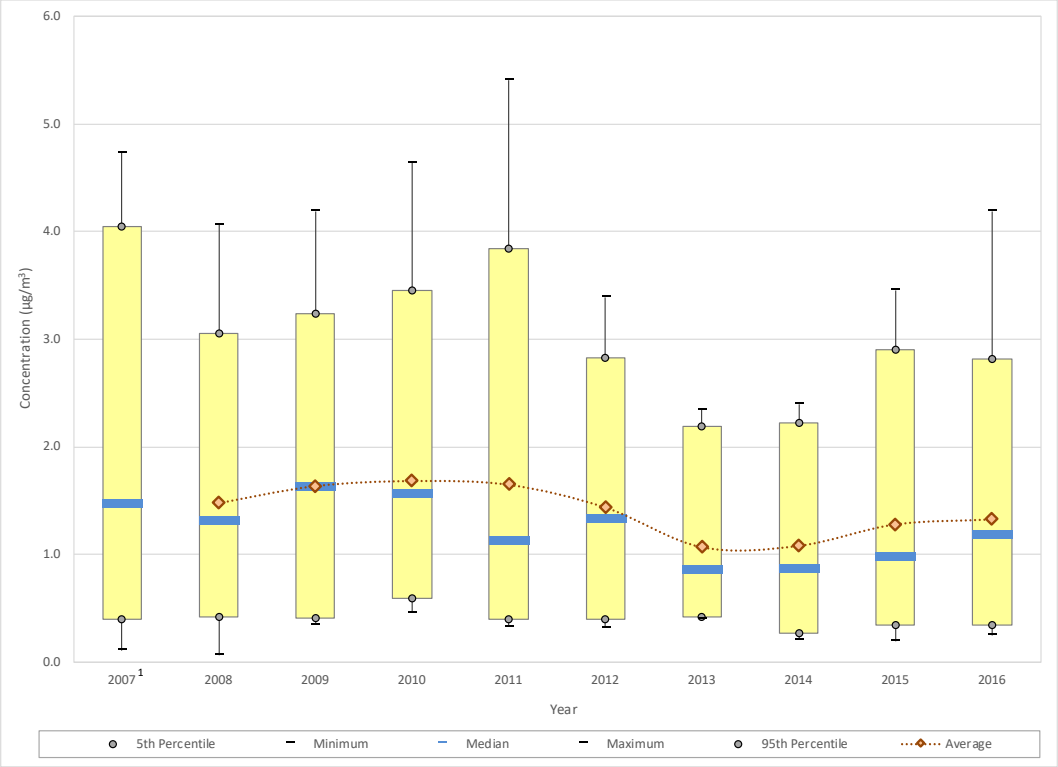
- PXSS began sampling PAHs under the NMP in July 2007. Because a full year's worth of data is not available, a 1-year average for 2007 is not presented, although the range of measurements is provided. Issues with the collection system resulted in completeness less than 85 percent for 2016, and thus, a 1-year average concentration for 2016 is not presented.

- The maximum naphthalene concentration was measured at PXSS on December 20, 2008 (400 ng/m^3), with a concentration of similar magnitude measured 12 days later on January 1, 2009 (386 ng/m^3). This is the same day that the maximum concentrations of several of PXSS's pollutants of interest were measured. Two additional naphthalene measurements greater than 300 ng/m^3 have been measured at PXSS, one in December 2012 and one in January 2014.

- Many of the statistical parameters are at a maximum for 2009. The median concentration, or midpoint, for 2009 is 107 ng/m^3; 2009 is the only year in which naphthalene concentrations greater than 100 ng/m^3 account for more than half of the measurements. The median concentrations for the other years are less than 100 ng/m^3, ranging from 52.30 ng/m^3 (2015) to 84.10 ng/m^3 (2010), and have a steady decreasing trend between 2009 and 2015. The 1-year average concentration is also at a maximum for 2009 (120.17 ng/m^3) and at a minimum for 2015 (74.36 ng/m^3).

- Naphthalene concentrations measured in 2016 have the smallest range of measurements shown, with 2016 the only full year of sampling for which less than 200 ng/m^3 separates the minimum and maximum concentrations measured. This data set missed the completeness criteria of 85 percent, as established in Section 2.4, by only 1 percent. Although a 1-year average concentration was not calculated for 2016, the median concentration shown in Figure 5-23 is at its highest since 2010.

Figure 5-24. Yearly Statistical Metrics for Benzene Concentrations Measured at SPAZ



[1] A 1-year average is not presented because sampling under the NMP did not begin until July 2007.

Observations from Figure 5-24 for benzene concentrations measured at SPAZ include the following:

- SPAZ also began sampling VOCs under the NMP in July 2007. Because a full year's worth of data is not available, a 1-year average concentration for 2007 is not presented, although the range of concentrations measured is provided.

- The maximum benzene concentration shown was measured on January 27, 2011 (5.41 µg/m^3) and is the only benzene concentration greater than 5 µg/m^3 measured at SPAZ. Six additional measurements greater than 4 µg/m^3 have been measured at this site (one for each year of sampling prior to 2012 and one in 2016).

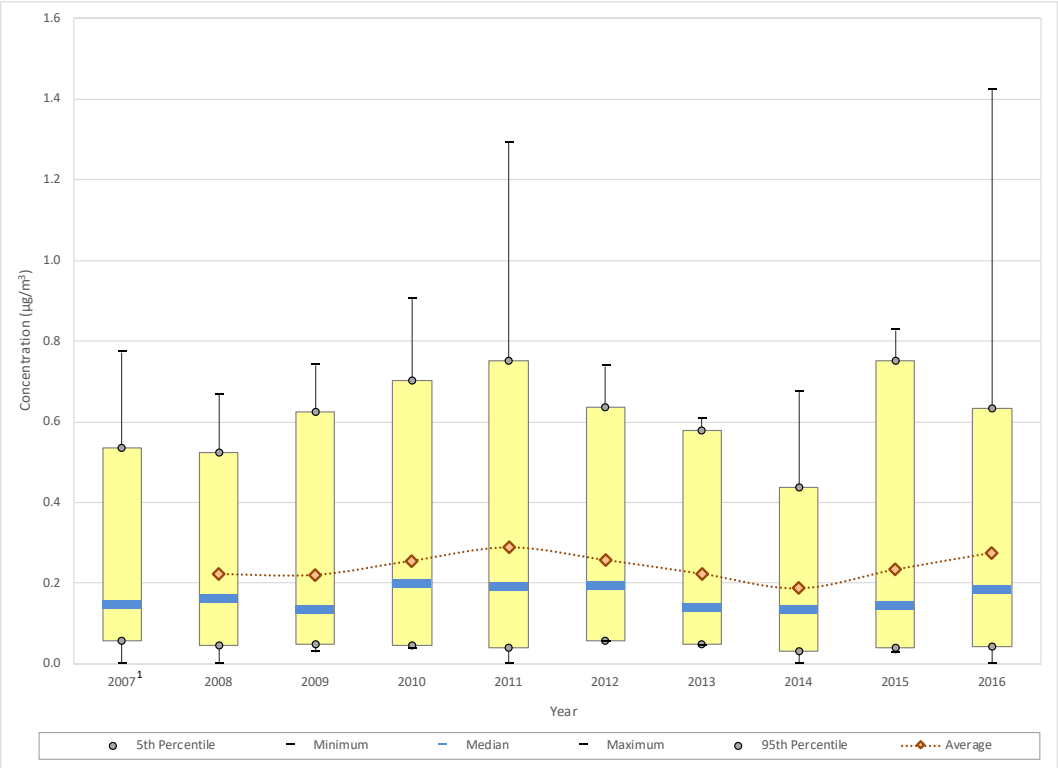
- Benzene concentrations measured at SPAZ exhibit a seasonal tendency; 65 of the 69 benzene concentrations greater than 2 µg/m^3 were measured at SPAZ during the first or fourth quarters of any given year.

- The 1-year average and median concentrations are fairly similar to each other for all years except 2011, when more than 0.5 µg/m^3 separates them. The largest range of benzene concentrations was measured in 2011, spanning more than 5 µg/m^3, and the maximum concentration for the period shown was measured in 2011. This year has the highest number of benzene concentrations greater than 3 µg/m^3 (5) but also the highest number of benzene concentrations less than 1.5 µg/m^3 (18) for the years prior to 2013.

- After several years of increasing, the maximum and 95th percentile decreased considerably for 2012 and again for 2013, with little change shown for 2014. The range of benzene concentrations measured is at a minimum for 2013, spanning less than 2 µg/m^3. The range of measurements increases for 2015 and again for 2016.

- The 1-year average concentrations changed little between 2009 and 2011, then decreased significantly from 2011 to 2013, with little change for 2014; afterwards, the 1-year average concentration begins to increase, though not significantly. The 1-year average concentrations range from 1.07 µg/m^3 (2013) to 1.69 µg/m^3 (2010) over the period shown; the median concentration exhibits more variability during this time frame.

Figure 5-25. Yearly Statistical Metrics for 1,3-Butadiene Concentrations Measured at SPAZ



[1] A 1-year average is not presented because sampling under the NMP did not begin until July 2007.

Observations from Figure 5-25 for 1,3-butadiene concentrations measured at SPAZ include the following:

- The maximum 1,3-butadiene concentration was measured at SPAZ on January 1, 2016 (1.42 µg/m^3). The only other 1,3-butadiene concentration greater than 1 µg/m^3 was measured at SPAZ on January 27, 2011 (1.29 µg/m^3). Six additional 1,3-butadiene concentrations greater than 0.75 µg/m^3 have been measured at SPAZ (one in 2007, two in 2010, one in 2011, and two in 2015).

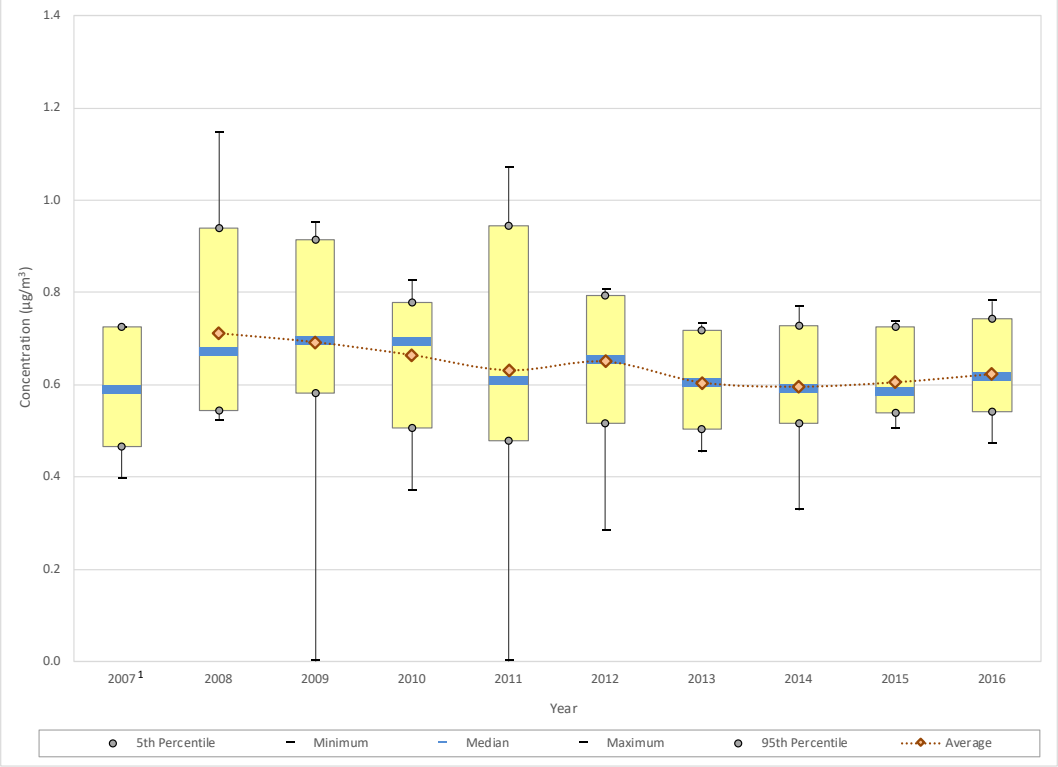
- Ninety-five of the 99 concentrations greater than 0.25 µg/m^3 were measured at SPAZ during the first or fourth quarters of any given year, similar to the seasonal tendency in the benzene measurements.

- The maximum concentration and 95th percentile increased each year after 2008 through 2011, while the 5th percentile remained fairly static. This indicates that more of the concentrations measured were on the higher end of the concentration range for each of these years. For 2012, the maximum concentration and 95th percentiles are lower, with the maximum concentration for 2012 less than the 95th percentile for 2011. This is also true for 2013, where the maximum concentration is less than the 95th percentile for the preceding year. The 95th percentile continued its decrease for 2014, although the maximum concentration measured increased. The majority of concentrations measured in 2014, as indicated by the 5th and 95th percentiles, falls into the tightest range among the years shown. This range expands considerably for

2015, resembling the concentration profile for 2011. The concentration profile for 2016 resembles the concentration profile for 2012, with the exception of the maximum concentration.

- The 1-year average concentration increases steadily between 2009 and 2011, then decreases through 2014, with the 1-year average concentration falling to less than 0.2 µg/m^3 for the first time in 2014. The 1-year average concentration increases in 2015 and again in 2016. However, the 1-year average concentrations vary by only 0.1 µg/m^3, ranging from 0.19 µg/m^3 (2014) to 0.29 µg/m^3 (2011), and confidence intervals calculated indicate these changes are not statistically significant.

Figure 5-26. Yearly Statistical Metrics for Carbon Tetrachloride Concentrations Measured at SPAZ



[1] A 1-year average is not presented because sampling under the NMP did not begin until July 2007.

Observations from Figure 5-26 for carbon tetrachloride concentrations measured at SPAZ include the following:

- Two concentrations of carbon tetrachloride greater than 1.0 µg/m^3 have been measured at SPAZ since the onset of sampling. One was measured in 2008 and one was measured in 2011 (although another concentration just less than 1 µg/m^3 was also measured in 2011). Conversely, two non-detects of carbon tetrachloride have been measured at SPAZ, one in 2009 and one in 2011.

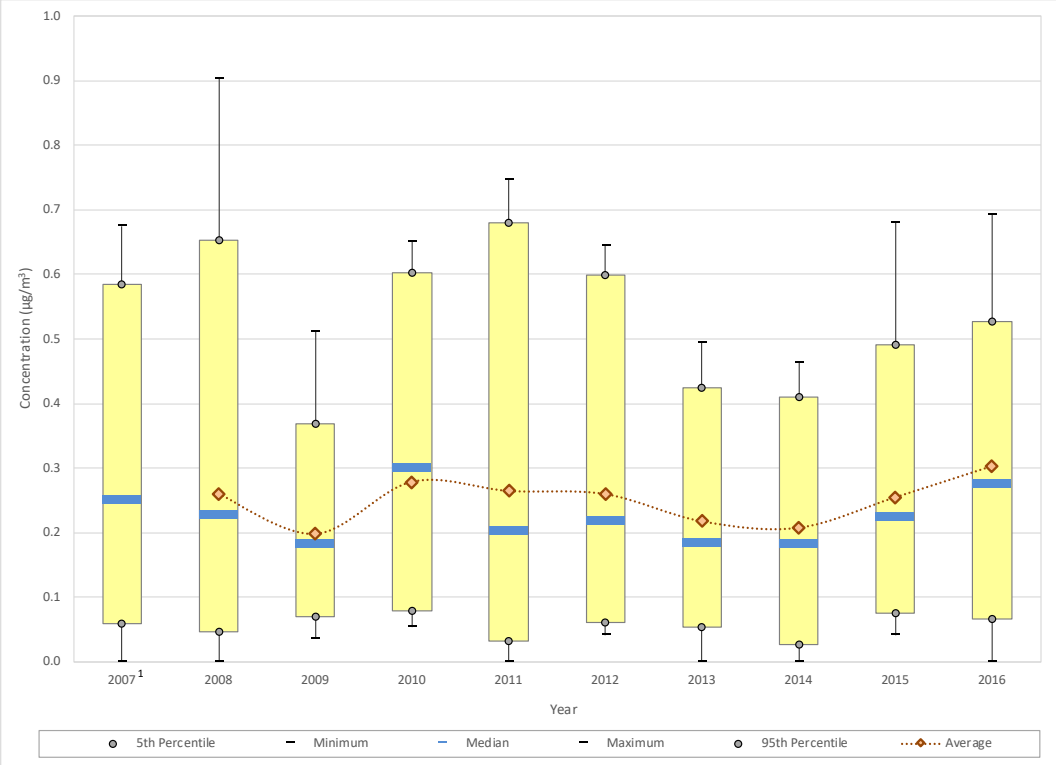
- The box and whisker plots for this pollutant appear "inverted" for several years, with the minimum concentration extending farther away from the majority of

measurements for several years rather than the maximum (see benzene or 1,3-butadiene as examples), which is more common.

- With the exception of 2012, the 1-year average concentration exhibits a slight decreasing trend over most of the years shown, reaching a minimum for 2014 (0.60 µg/m^3). However, the overall change for this period is less than 0.12 µg/m^3. Slight increases are shown for 2015 and 2016.

- The range of concentrations measured is at a minimum for 2015, with less than 0.25 µg/m^3 separating the minimum and maximum concentrations measured.

Figure 5-27. Yearly Statistical Metrics for *p*-Dichlorobenzene Concentrations Measured at SPAZ



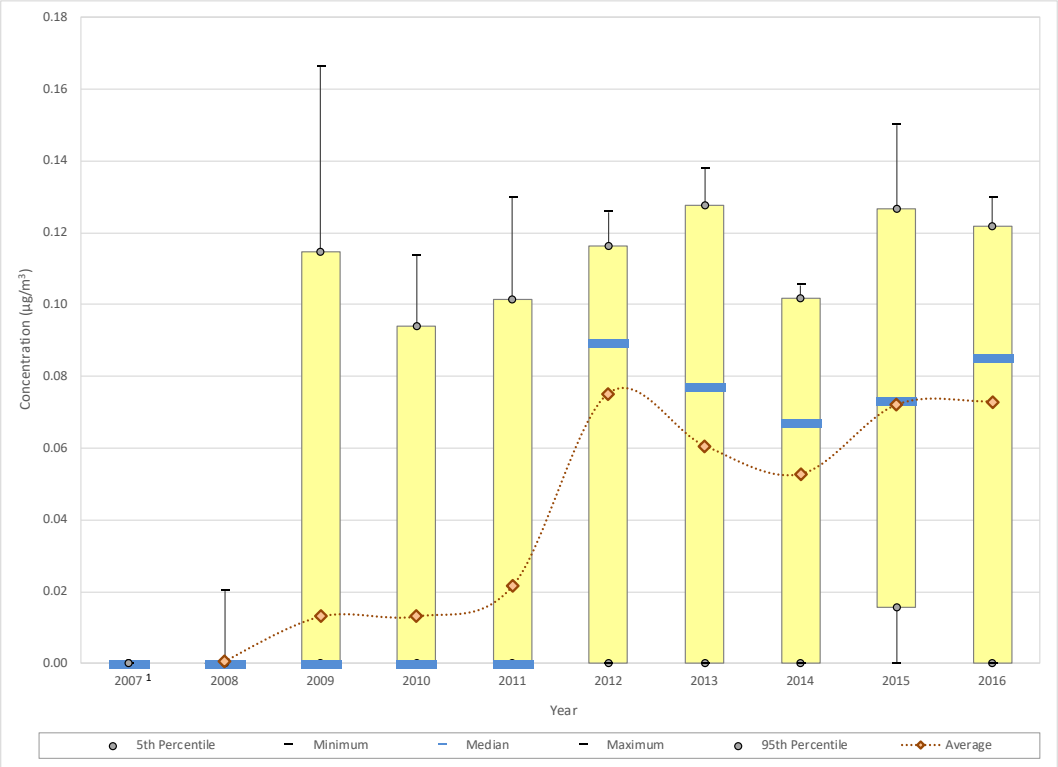
[1] A 1-year average is not presented because sampling under the NMP did not begin until July 2007.

Observations from Figure 5-27 for *p*-dichlorobenzene concentrations measured at SPAZ include the following:

- The widest range of *p*-dichlorobenzene concentrations measured is shown for 2008 (ranging from a single non-detect to 0.90 µg/m^3), while the range of concentrations measured the following year is roughly half as large. A review of the data shows that the number of *p*-dichlorobenzene concentrations greater than 0.3 µg/m^3 decreased by half from 2008 (8) to 2009 (4). All of the statistical metrics exhibit increases from 2009 to 2010, with the number of *p*-dichlorobenzene concentrations greater than 0.3 µg/m^3 increasing nearly four-fold (15).

- The 1-year average concentration decreased from 2008 to 2009, increased for 2010, then decreased slightly each year between 2011 and 2014. The 1-year average concentration exhibits an increase for 2015 and again for 2016, increasing by nearly 50 percent between 2014 and 2016, and reaching a maximum of 0.30 µg/m^3. However, confidence intervals calculated for these averages indicate that the changes are not statistically significant.

Figure 5-28. Yearly Statistical Metrics for 1,2-Dichloroethane Concentrations Measured at SPAZ



[1] A 1-year average is not presented because sampling under the NMP did not begin until July 2007.

Observations from Figure 5-28 for 1,2-dichloroethane concentrations measured at SPAZ include the following:

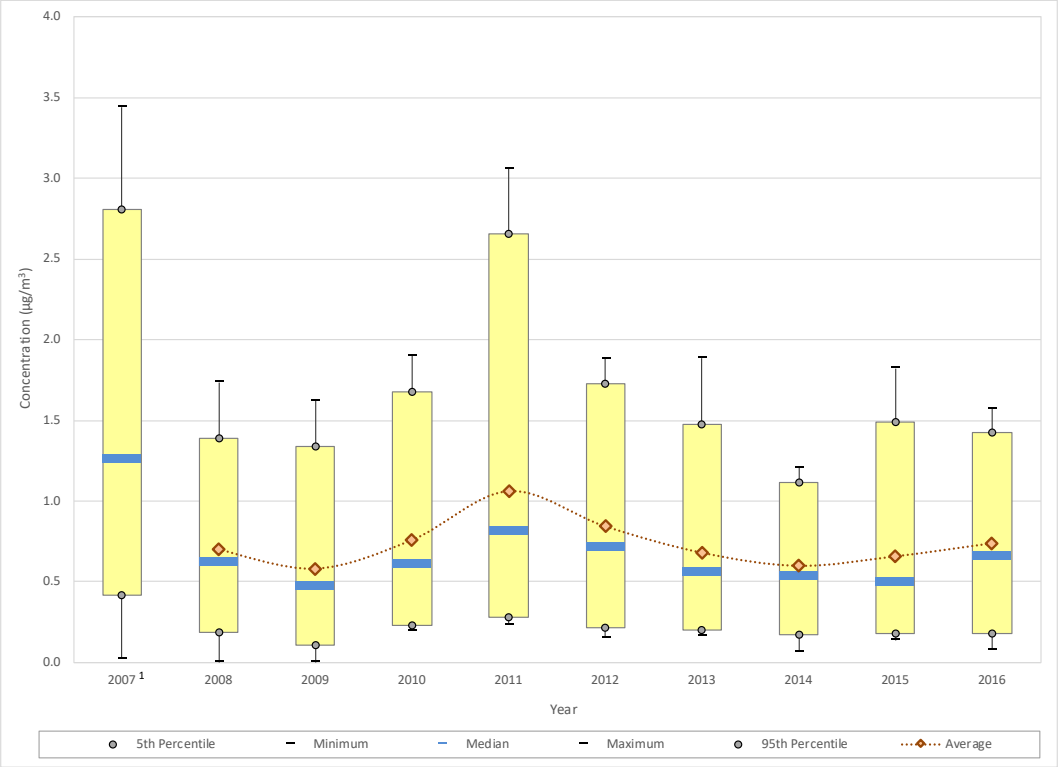
- There were no measured detections of 1,2-dichloroethane in 2007 and only one measured in 2008. The number of measured detections increased slightly each year through 2011, then increased substantially in 2012, with measured detections accounting for nearly 87 percent of the measurements. Between 2012 and 2016, measured detections account for between 61 (2013) and 94 percent (2015) of the measurements.

- The median concentration is zero for each year until 2012, indicating that at least 50 percent of the measurements were non-detects. As the number of measured detections increase, so do the corresponding central tendency statistics shown in Figure 5-28.

- The median concentration is greater than the 1-year average concentration for each year beginning with 2012. This is because the non-detects (or zeros) factored into each 1-year average concentration are pulling the average down in the same manner that a maximum or outlier concentration can drive the average upward. These two central tendency statistics are closest for 2015 when there were only two non-detects.

- Between 2012 and 2016, the 1-year average concentrations vary by less than 0.025 µg/m^3, despite the apparent fluctuations shown in Figure 5-28. Confidence intervals calculated for the last five years of sampling indicate that the changes shown in the 1-year average concentrations are not statistically significant due to the variability in the concentrations measured.

Figure 5-29. Yearly Statistical Metrics for Ethylbenzene Concentrations Measured at SPAZ



[1] A 1-year average is not presented because sampling under the NMP did not begin until July 2007.

Observations from Figure 5-29 for ethylbenzene concentrations measured at SPAZ include the following:

- Two concentrations of ethylbenzene greater than 3.0 µg/m^3 have been measured at SPAZ (one in 2007 and one in 2011). All 10 concentrations greater than 2.0 µg/m^3 were measured in either 2007 or 2011 (five each year).

- The median concentration is at a maximum for 2007, then decreases by half for 2008. (2007 includes only half a year's worth of samples). Further decreases are shown for 2009, followed by an increase in 2010 and again in 2011. The median concentration

decreases for 2012, with additional decreases for each year through 2015. The median concentration for 2016 increases for the first time since 2011.

- The 1-year average concentrations have a similar pattern as the median concentration through 2014. A significant increasing trend is shown between 2009 and 2011, which is followed by a significant decreasing trend through 2014. The 1-year average concentration exhibits an increase for 2015 and again for 2016. These patterns are similar to the patterns shown for 1,3-butadiene in Figure-5-25.

- The only non-detects of ethylbenzene were measured during the first two full-years of sampling at SPAZ.

5.4 Additional Risk-Based Screening Evaluations

The following risk-based screening evaluations were conducted to characterize risk related to the air toxics measured at each Arizona monitoring site. Refer to Sections 3.2, 3.4.2.3, and 3.4.2.4 for definitions and explanations regarding the various toxicity factors, time frames, and calculations associated with these risk-based screenings.

5.4.1 Cancer Risk and Noncancer Hazard Approximations

For the pollutants of interest for the Arizona monitoring sites, risk was examined by calculating cancer risk and noncancer hazard approximations for each year annual average concentrations could be calculated. These approximations can be used as risk estimates for cancer and noncancer effects attributable to the pollutants of interest. Although the use of these approximations is limited, they may help identify where policy-makers want to shift their air monitoring priorities. Refer to Section 3.4.2.3 for an explanation of how cancer risk and noncancer hazard approximations are calculated and what limitations are associated with them. Annual averages, cancer UREs and/or noncancer RfCs, and cancer risk and noncancer hazard approximations are presented in Table 5-4, where applicable. Cancer risk approximations are presented as probabilities while the noncancer hazard approximations are ratios and thus, unitless values.

Table 5-4. Risk Approximations for the Arizona Monitoring Sites

Pollutant	Cancer URE ($\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	2015				2016			
			# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Risk Approximations		# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Risk Approximations	
					Cancer (in-a-million)	Noncancer (HQ)			Cancer (in-a-million)	Noncancer (HQ)
Phoenix, Arizona - PXSS										
Acetaldehyde	0.0000022	0.009	33/33	NA	NA	NA	58/58	2.75 ± 0.28	6.04	0.31
Benzene	0.0000078	0.03	58/58	1.04 ± 0.21	8.13	0.03	60/60	1.13 ± 0.19	8.83	0.04
1,3-Butadiene	0.00003	0.002	58/58	0.20 ± 0.05	5.86	0.10	60/60	0.22 ± 0.05	6.64	0.11
Carbon Tetrachloride	0.000006	0.1	58/58	0.63 ± 0.02	3.76	0.01	60/60	0.61 ± 0.03	3.65	0.01
p-Dichlorobenzene	0.000011	0.8	53/58	0.15 ± 0.03	1.65	<0.01	59/60	0.20 ± 0.03	2.21	<0.01
1,2-Dichloroethane	0.000026	2.4	55/58	0.08 ± 0.01	2.09	<0.01	55/60	0.09 ± 0.01	2.36	<0.01
Ethylbenzene	0.0000025	1	58/58	0.54 ± 0.12	1.35	<0.01	60/60	0.65 ± 0.11	1.63	<0.01
Formaldehyde	0.000013	0.0098	33/33	NA	NA	NA	58/58	3.80 ± 0.27	49.36	0.39
Arsenic (PM_{10})	0.0043	0.000015	59/59	0.57 ± 0.09	2.45	0.04	61/61	0.71 ± 0.16	3.07	0.05
Naphthalene	0.000034	0.003	55/55	74.36 ± 15.68	2.53	0.02	51/51	NA	NA	NA

[a] Average concentrations provided for the pollutants below the blue line are presented in ng/m^3 for ease of viewing.
NA = Not available because the criteria for calculating an annual average were not met.

Table 5-4. Risk Approximations for the Arizona Monitoring Sites (Continued)

Pollutant	Cancer URE ($\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	2015				2016			
			# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Risk Approximations		# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Risk Approximations	
					Cancer (in-a-million)	Noncancer (HQ)			Cancer (in-a-million)	Noncancer (HQ)
South Phoenix, Arizona - SPAZ										
Benzene	0.0000078	0.03	32/32	1.28 ± 0.31	10.00	0.04	31/31	1.33 ± 0.32	10.36	0.04
1,3-Butadiene	0.00003	0.002	32/32	0.23 ± 0.08	7.02	0.12	30/31	0.27 ± 0.10	8.25	0.14
Carbon Tetrachloride	0.000006	0.1	32/32	0.60 ± 0.02	3.63	0.01	31/31	0.62 ± 0.02	3.73	0.01
p-Dichlorobenzene	0.000011	0.8	32/32	0.25 ± 0.06	2.80	<0.01	30/31	0.30 ± 0.06	3.33	<0.01
1,2-Dichloroethane	0.000026	2.4	30/32	0.07 ± 0.01	1.87	<0.01	26/31	0.07 ± 0.01	1.90	<0.01
Ethylbenzene	0.0000025	1	32/32	0.66 ± 0.15	1.64	<0.01	31/31	0.74 ± 0.14	1.84	<0.01

[a] Average concentrations provided for the pollutants below the blue line are presented in ng/m^3 for ease of viewing.
NA = Not available because the criteria for calculating an annual average were not met.

Observations for PXSS from Table 5-4 include the following:

- The pollutants of interest with the highest annual average concentrations for 2015 (without the carbonyl compounds) are different than those for 2016 (with the carbonyl compounds). The pollutants of interest with the highest annual average concentrations for 2015 are benzene, carbon tetrachloride, and ethylbenzene. The pollutants of interest with the highest annual average concentrations for 2016 are formaldehyde, acetaldehyde, and benzene. For the VOCs, the annual averages for 2015 are similar to the annual averages for 2016.

- Based on the annual averages for 2015 and cancer UREs, all of the cancer risk approximations are less than 10 in-a-million; benzene has the highest cancer risk approximation (8.13 in-a-million). For 2016, the pollutant with the highest cancer risk approximation is formaldehyde (49.36 in-a-million).

- None of the pollutants of interest for PXSS have noncancer hazard approximations greater than 1.0, indicating that no adverse noncancer health effects are expected from these individual pollutants. The pollutant with the highest noncancer hazard approximation for 2015 is benzene (0.10). The pollutant with the highest noncancer hazard approximation for 2016 is formaldehyde (0.39).

Observations for SPAZ from Table 5-4 include the following:

- The pollutants with the highest annual average concentrations for SPAZ are the same for both years: benzene, ethylbenzene, and carbon tetrachloride. Only benzene's annual average concentrations are greater than 1 $\mu g/m^3$.

- Based on the annual averages and cancer UREs, benzene has the highest cancer risk approximations for both years, followed by 1,3-butadiene, and carbon tetrachloride. The cancer risk approximations for benzene (10.00 in-a-million for 2015 and 10.36 in-a-million for 2016) are the only ones greater than 10 in-a-million for SPAZ and are the highest cancer risk approximations calculated across the program for this pollutant.

- None of the pollutants of interest for SPAZ have noncancer hazard approximations greater than 1.0, indicating no adverse noncancer health effects are expected from these individual pollutants. The pollutant with the highest noncancer hazard approximation for SPAZ is 1,3-butadiene (0.12 for 2015 and 0.14 for 2016).

5.4.2 Risk-Based Emissions Assessment

In addition to the risk-based screening discussed above, this section presents an evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 5-5 presents the 10 pollutants with the highest emissions from the 2014 NEI (version 1) that have cancer toxicity factors. Table 5-5 also presents the 10 pollutants with the highest toxicity-weighted emissions, based on the weighting schema described in Section 3.4.3.4. Lastly, Table 5-5 provides the pollutants of interest with the highest cancer risk approximations (in-a-million) for each site, as presented in Table 5-4. Cancer risk approximations for 2015 are presented in green while approximations for 2016 are in white. The emissions, toxicity-weighted emissions, and cancer risk approximations are shown in descending order in Table 5-5. Table 5-6 presents similar information but is limited to those pollutants with noncancer toxicity factors.

Because not all pollutants have both cancer and noncancer toxicity factors, the highest emitted pollutants in the cancer table may be different from the noncancer table, although the actual quantity of emissions is the same. The cancer risk and noncancer hazard approximations based on each site's annual averages are limited to the pollutants of interest identified for each site. In addition, the cancer risk and noncancer hazard approximations are limited to those pollutants with enough data to meet the criteria for annual averages to be calculated. A more in-depth discussion of this analysis is provided in Section 3.4.2.4. Similar to the cancer risk and noncancer hazard approximations provided in Section 5.4.1, this analysis may help policy-makers prioritize their air monitoring activities.

Table 5-5. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Arizona Monitoring Sites

Top 10 Total Emissions for Pollutants with Cancer UREs (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Phoenix, Arizona (Maricopa County) – PXSS					
Formaldehyde	944.58	Formaldehyde	1.23E-02	Formaldehyde	49.36
Benzene	897.31	Naphthalene	8.70E-03	Benzene	8.83
Ethylbenzene	558.42	Benzene	7.00E-03	Benzene	8.13
Acetaldehyde	514.05	1,3-Butadiene	3.82E-03	1,3-Butadiene	6.64
Naphthalene	255.84	POM, Group 2b	1.72E-03	Acetaldehyde	6.04
Bis(2-ethylhexyl) phthalate	149.76	Ethylbenzene	1.40E-03	1,3-Butadiene	5.86
1,3-Butadiene	127.30	POM, Group 2d	1.18E-03	Carbon Tetrachloride	3.76
POM, Group 2b	19.51	Acetaldehyde	1.13E-03	Carbon Tetrachloride	3.65
POM, Group 2d	13.42	POM, Group 5a	1.07E-03	Arsenic	3.07
2,4-Toluene diisocyanate	12.83	Arsenic, PM	3.95E-04	Naphthalene	2.53
South Phoenix, Arizona (Maricopa County) – SPAZ					
Formaldehyde	944.58	Formaldehyde	1.23E-02	Benzene	10.36
Benzene	897.31	Naphthalene	8.70E-03	Benzene	10.00
Ethylbenzene	558.42	Benzene	7.00E-03	1,3-Butadiene	8.25
Acetaldehyde	514.05	1,3-Butadiene	3.82E-03	1,3-Butadiene	7.02
Naphthalene	255.84	POM, Group 2b	1.72E-03	Carbon Tetrachloride	3.73
Bis(2-ethylhexyl) phthalate	149.76	Ethylbenzene	1.40E-03	Carbon Tetrachloride	3.63
1,3-Butadiene	127.30	POM, Group 2d	1.18E-03	*p*-Dichlorobenzene	3.33
POM, Group 2b	19.51	Acetaldehyde	1.13E-03	*p*-Dichlorobenzene	2.80
POM, Group 2d	13.42	POM, Group 5a	1.07E-03	1,2-Dichloroethane	1.90
2,4-Toluene diisocyanate	12.83	Arsenic, PM	3.95E-04	1,2-Dichloroethane	1.87

[1]Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Table 5-6. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the Arizona Monitoring Sites

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Hazard Approximation (HQ)**
Phoenix, Arizona (Maricopa County) – PXSS					
Toluene	3,935.87	Acrolein	3,491,697.55	Formaldehyde	0.39
Xylenes	2,003.31	2,4-Toluene diisocyanate	183,229.29	Acetaldehyde	0.31
Methanol	1,807.93	Formaldehyde	96,385.87	1,3-Butadiene	0.11
Formaldehyde	944.58	Naphthalene	85,280.03	1,3-Butadiene	0.10
Benzene	897.31	1,3-Butadiene	63,648.01	Arsenic	0.05
Hexane	789.32	Acetaldehyde	57,116.24	Arsenic	0.04
Ethylbenzene	558.42	Lead, PM	30,072.62	Benzene	0.04
Acetaldehyde	514.05	Benzene	29,910.26	Benzene	0.03
Naphthalene	255.84	Xylenes	20,033.14	Naphthalene	0.02
Ethylene glycol	206.28	Bis(2-ethylhexyl) phthalate, gas	14,976.35	Carbon Tetrachloride	0.01
South Phoenix, Arizona (Maricopa County) – SPAZ					
Toluene	3,935.87	Acrolein	3,491,697.55	1,3-Butadiene	0.14
Xylenes	2,003.31	2,4-Toluene diisocyanate	183,229.29	1,3-Butadiene	0.12
Methanol	1,807.93	Formaldehyde	96,385.87	Benzene	0.04
Formaldehyde	944.58	Naphthalene	85,280.03	Benzene	0.04
Benzene	897.31	1,3-Butadiene	63,648.01	Carbon Tetrachloride	0.01
Hexane	789.32	Acetaldehyde	57,116.24	Carbon Tetrachloride	0.01
Ethylbenzene	558.42	Lead, PM	30,072.62	Ethylbenzene	<0.01
Acetaldehyde	514.05	Benzene	29,910.26	Ethylbenzene	<0.01
Naphthalene	255.84	Xylenes	20,033.14	*p*-Dichlorobenzene	<0.01
Ethylene glycol	206.28	Bis(2-ethylhexyl) phthalate, gas	14,976.35	*p*-Dichlorobenzene	<0.01

[1]Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Observations from Table 5-5 include the following:

- Formaldehyde, benzene, and ethylbenzene are the highest emitted pollutants with cancer UREs in Maricopa County.

- The pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) are formaldehyde, naphthalene, and benzene.

- Eight of the highest emitted pollutants in Maricopa County also have the highest toxicity-weighted emissions.

- Formaldehyde (2016) has the highest cancer risk approximation for PXSS. Formaldehyde has also the highest emissions and the highest toxicity-weighted emissions for Maricopa County. Acetaldehyde (2016) also appears on all three lists. Carbonyl compounds were not sampled for at SPAZ, thus, cancer risk approximations are not available for this pollutant for SPAZ.

- Among the VOCs, benzene, 1,3-butadiene, and carbon tetrachloride have the highest cancer risk approximations for PXSS and SPAZ. The cancer risk approximations for benzene and 1,3-butadiene for SPAZ are slightly higher than those for PXSS, but the cancer risk approximations for carbon tetrachloride are very similar between the two sites. While benzene and 1,3-butadiene both appear among the pollutants with the highest emissions and highest toxicity-weighted emissions for Maricopa County, carbon tetrachloride does not appear on either list, ranking 25th for quantity emitted and 32nd for it toxicity-weighted emissions.

- Naphthalene is among the highest emitted pollutants (fifth), has the second highest toxicity-weighted emissions, and has the 10th highest cancer risk approximations for PXSS (2015). POM, Groups 2b and 2d are among the highest emitted "pollutants" in Maricopa County and rank among those with the highest toxicity-weighted emissions. POM, Group 2b includes several PAHs sampled for at PXSS including acenaphthene, benzo(e)pyrene, fluoranthene, and perylene. None of the PAHs included in POM, Group 2b were identified as pollutants of interest for PXSS (or failed any screens). POM, Group 2d does not include any pollutants sampled for at PXSS.

- Arsenic (2016) has the ninth highest cancer risk approximation among the pollutants of interest for PXSS. This pollutant ranks tenth for its toxicity-weighted emissions but does not appear among the highest emitted pollutants in Maricopa County (it ranks 24th).

Observations from Table 5-6 include the following:

- Toluene, xylenes, and methanol are the highest emitted pollutants with noncancer RfCs in Maricopa County.

- The pollutants with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) are acrolein, 2,4-toluene diisocyanate, and formaldehyde.

- Five of the highest emitted pollutants also have the highest toxicity-weighted emissions for Maricopa County.

- Acrolein has the highest toxicity-weighted emissions for Maricopa County. Although acrolein was sampled for at both sites, this pollutant was excluded from the pollutants of interest designation, and thus subsequent risk-based screening evaluations, due to questions about the consistency and reliability of the measurements, as discussed in Section 3.2. The emissions for acrolein rank 15th for Maricopa County.

- All of the noncancer hazard approximations calculated for PXSS and SPAZ are less than an HQ of 1.0. Formaldehyde and acetaldehyde have the highest noncancer hazard approximations for PXSS, both of which appear among those pollutants with the highest emissions and toxicity-weighted emissions for Maricopa County.

- 1,3-Butadiene has the highest noncancer hazard approximations among the VOCs for both PXSS and SPAZ. This pollutant ranks fifth for its toxicity-weighted emissions but does not appear among the highest emitted in Maricopa County (it ranks 12th).

- For PXSS, noncancer risk approximations for arsenic, benzene, naphthalene (2015), and carbon tetrachloride (2015) also appear in Table 5-6. Benzene ranks fifth for its total emissions and eighth for its toxicity-weighted emissions. Naphthalene also appears on both emissions-based lists, ranking ninth for its total emissions and fourth for its toxicity-weighted emissions. Arsenic and carbon tetrachloride do not appear on either emissions-based list.

- In addition to 1,3-butadiene, benzene, carbon tetrachloride, ethylbenzene, and *p*-dichlorobenzene have the highest noncancer hazard approximations for SPAZ. For each pollutant, noncancer risk approximations for both years are shown in Table 5-6 and are similar to each other. Benzene appears on both emissions-based list; ethylbenzene ranks seventh for its total emissions in Maricopa County, but does not appear among those with the highest toxicity-weighted emissions; and carbon tetrachloride and *p*-dichlorobenzene appear on neither emissions-based list.

5.5 Summary of the 2015-2016 Monitoring Data for PXSS and SPAZ

Results from several of the data analyses described in this section include the following:

- ❖ *Twenty pollutants failed screens for PXSS; eight pollutants failed screens for SPAZ.*

- ❖ *Of the site-specific pollutants of interest for PXSS, formaldehyde had the highest annual average concentration, though 2016 was the only year for which an annual average could be calculated. For SPAZ, benzene had the highest annual average concentration (both years) among this site's pollutants of interest.*

- ❖ *Concentrations of several VOCs, particularly benzene and 1,3-butadiene, tended to be higher during the colder months of the year. This was also reflected in the concentration data from previous years of sampling.*

- ❖ *SPAZ has the highest annual average concentrations of benzene, p-dichlorobenzene, and ethylbenzene among NMP sites sampling VOCs, as well as the second and third highest annual average concentrations of 1,3-butadiene. Annual average concentrations of these pollutant for PXSS also rank among the highest calculated across the program.*

- *The most significant trends shown for the pollutants of interest for PXSS are for 1,2-dichloroethane; the detection rate of 1,2-dichloroethane increased significantly during the later years of sampling, with the 1-year average concentration at a maximum for 2016. This increase in the detection rate also occurred at SPAZ. For SPAZ, the maximum 1,3-butadiene concentration measured since the onset of sampling at this site (10 years) was measured in 2016.*

- *Formaldehyde has the highest cancer risk approximation among the pollutants of interest for PXSS; benzene has the highest cancer risk approximation among the pollutants of interest for SPAZ. None of the pollutants of interest for either site have noncancer hazard approximations greater than an HQ of 1.0.*

6.0 Sites in California

This section examines those data from samples collected at three NATTS sites in California and generated by ERG, EPA's contract laboratory for the NMP, over the 2015 and 2016 monitoring efforts. This section also examines the spatial and temporal characteristics of the ambient monitoring concentrations and reviews them through the context of risk. Readers are encouraged to refer to Sections 1 through 4 for detailed discussions and definitions regarding the various data analyses presented below.

> Data generated by sources other than ERG, EPA's contract laboratory for the NMP, are not included in the data analyses contained in this report.

6.1 Site Characterization

This section characterizes the California monitoring sites by providing a description of the nearby area surrounding each monitoring site; plotting emissions sources surrounding the monitoring sites; and presenting traffic data and other characterizing information for each site. This information is provided to give the reader insight regarding factors that may influence the air quality near the sites and assist in the interpretation of the ambient measurements.

Three NATTS monitoring sites are located in California. Two are located in Southern California, specifically in Los Angeles (CELA) and Rubidoux (RUCA), and a third monitoring site is located in Northern California, in San Jose (SJJCA). Figure 6-1 presents a composite satellite image retrieved from ArcGIS Explorer showing the CELA monitoring site and its immediate surroundings. Figure 6-2 identifies nearby point source emissions locations by source category, as reported in the 2014 NEI for point sources, version 1. Note that only sources within 10 miles of CELA are included in the facility counts provided in Figure 6-2. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have a direct effect on the air quality at the monitoring site. Further, this boundary provides both the proximity of emissions sources to the monitoring site as well as the quantity of such sources within a given distance of the site. Sources outside the 10-mile boundary are still visible on the map for reference but have been grayed out to emphasize emissions sources within the boundary. Figures 6-3 through 6-6 present the composite satellite images and emissions maps for the Rubidoux and San Jose monitoring sites. Table 6-1 provides supplemental geographical information such as land use, location setting, and locational coordinates. Each figure and table is discussed in detail in the paragraphs that follow.

Figure 6-1. Los Angeles, California (CELA) Monitoring Site

Figure 6-2. NEI Point Sources Located Within 10 Miles of CELA

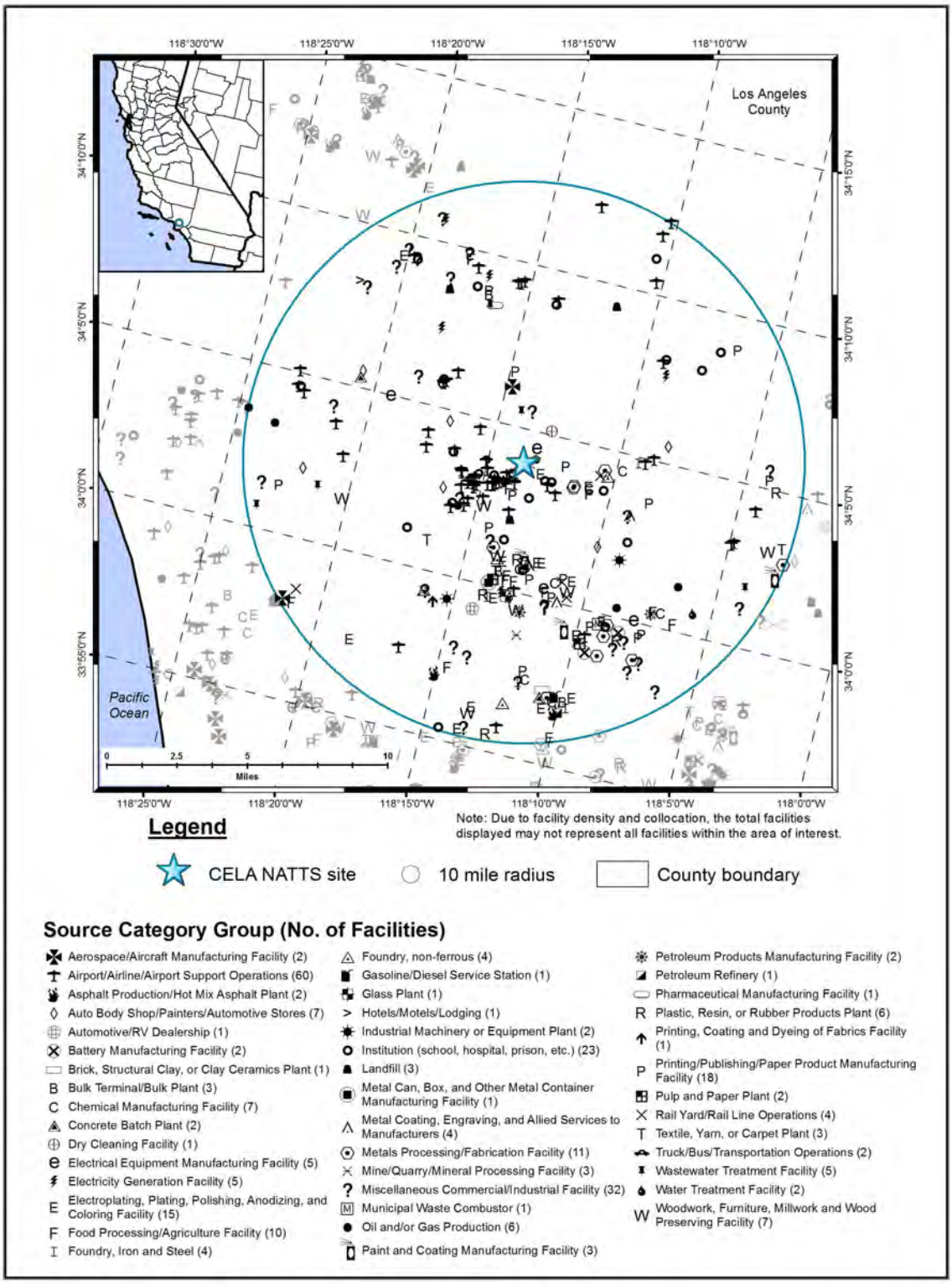


Figure 6-3. Rubidoux, California (RUCA) Monitoring Site

Figure 6-4. NEI Point Sources Located Within 10 Miles of RUCA

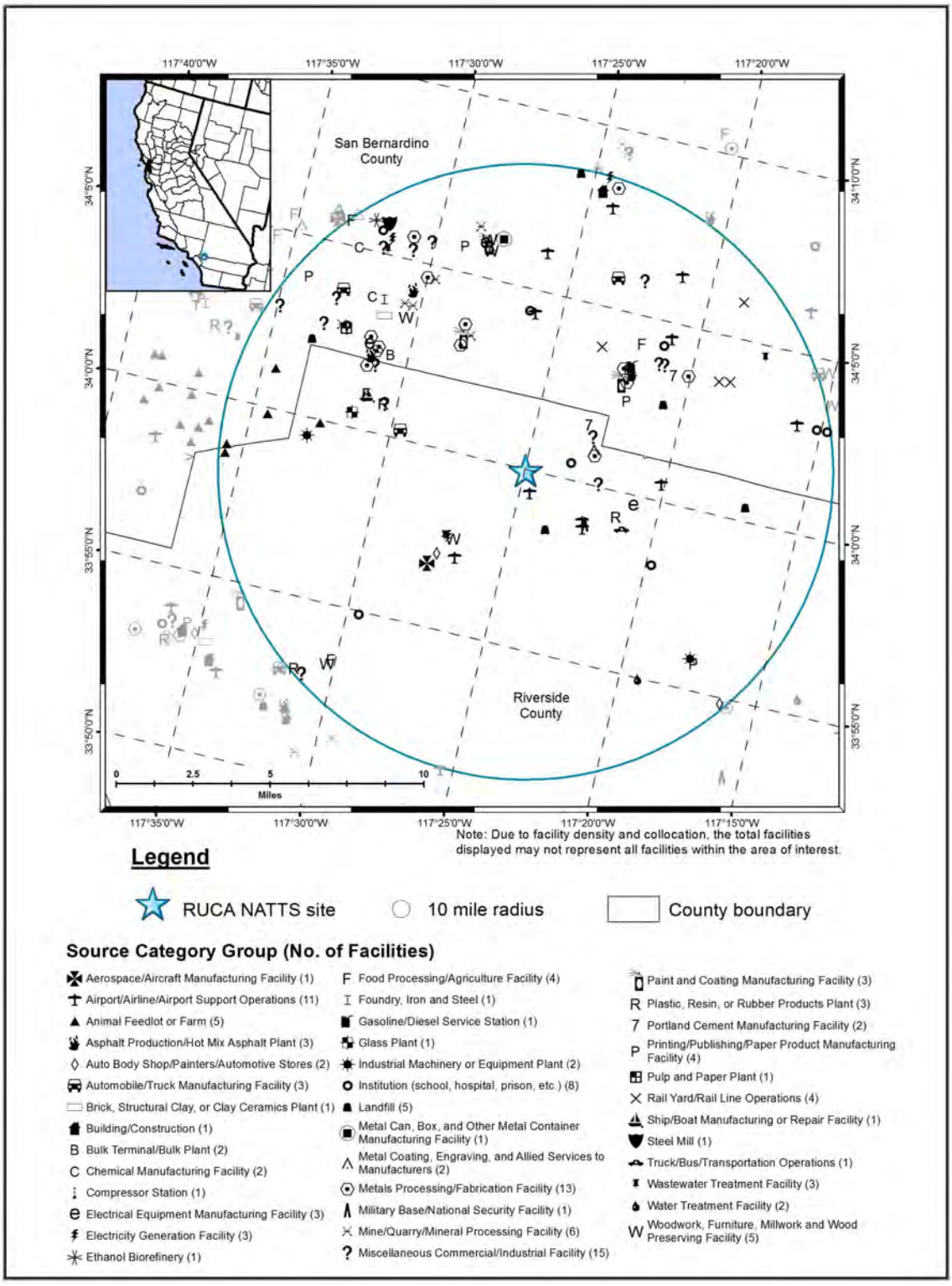


Figure 6-5. San Jose, California (SJJCA) Monitoring Site

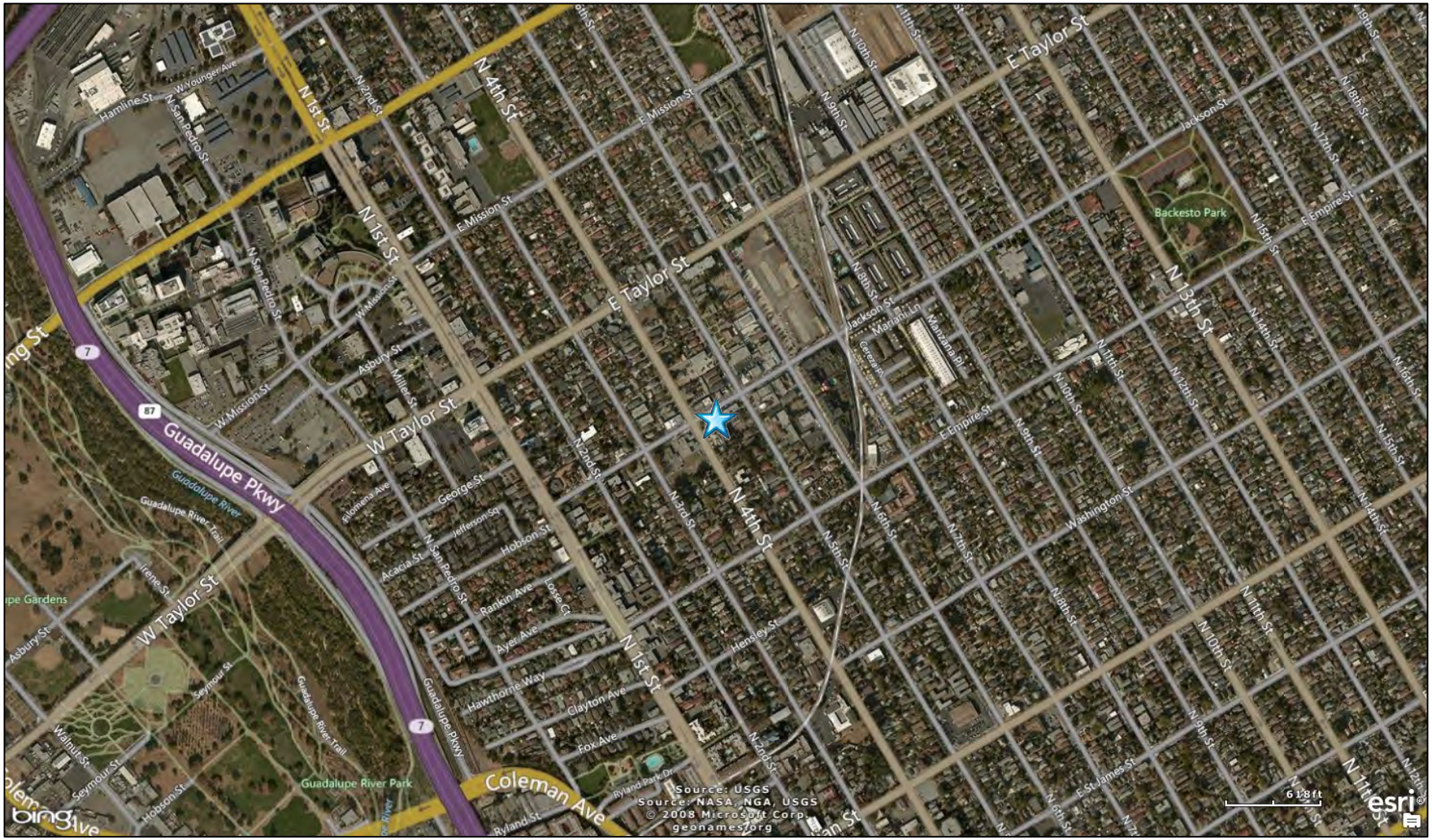


Figure 6-6. NEI Point Sources Located Within 10 Miles of SJJCA

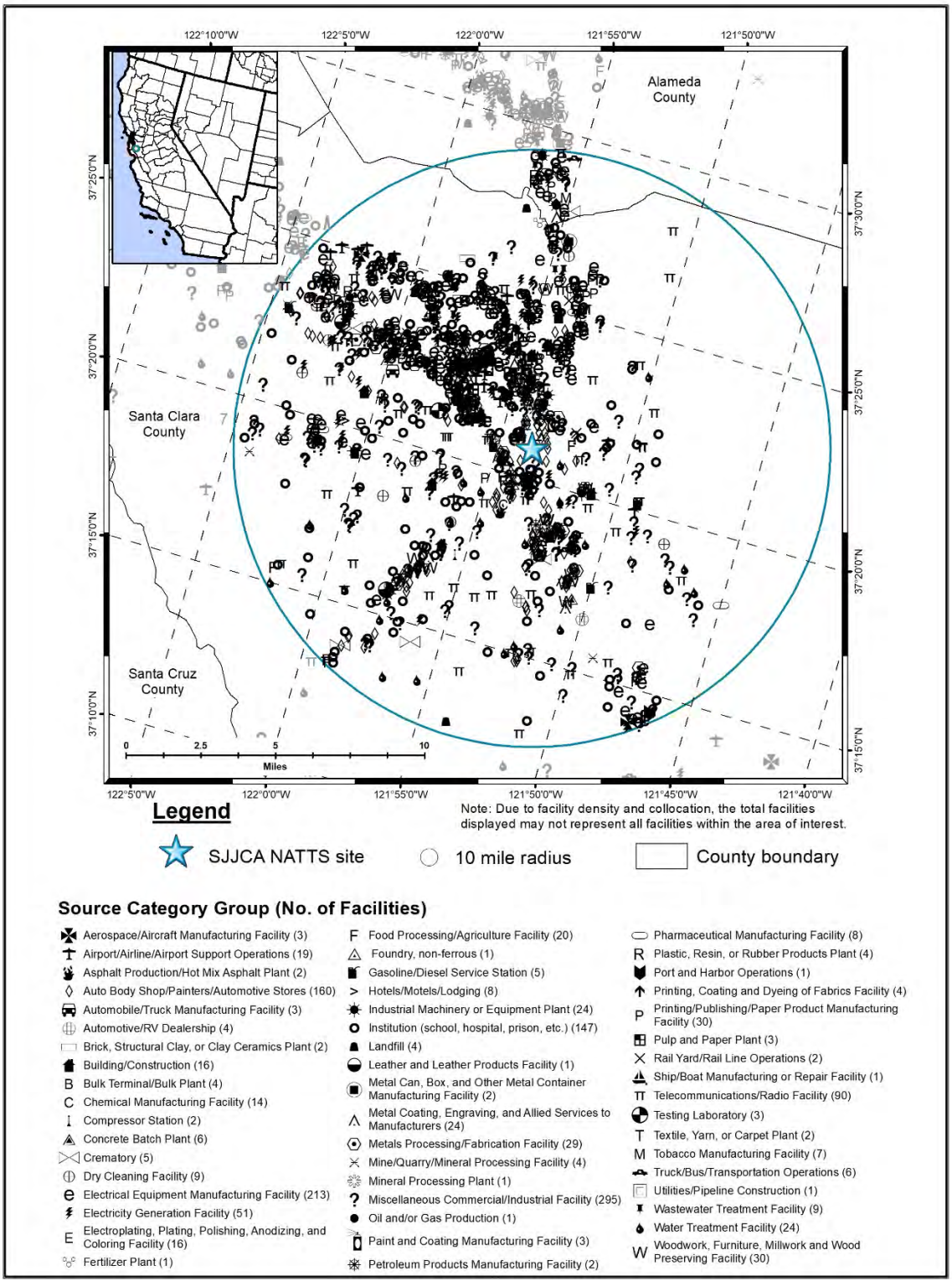


Table 6-1. Geographical Information for the California Monitoring Sites

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Annual Average Daily Traffic[1]	Intersection Used for Traffic Data
CELA	06-037-1103	Los Angeles	Los Angeles	Los Angeles-Long Beach-Anaheim, CA	34.066590, -118.226880	Residential	Urban/City Center	231,000	I-5 between Main St. and Broadway (exit 136 and 137)
RUCA	06-065-8001	Rubidoux	Riverside	Riverside-San Bernardino-Ontario, CA	33.999580, -117.416010	Residential	Suburban	166,000	Rte 60 (Mission Blvd) between Rubidoux Blvd and Valley Way
SJJCA	06-085-0005	San Jose	Santa Clara	San Jose-Sunnyvale-Santa Clara, CA	37.348497, -121.894898	Commercial	Urban/City Center	126,000	Rte 87 (Guadalupe Pkwy) between Julian St and W Taylor St

[1]AADT reflects 2015 data (CA DOT, 2015)
BOLD ITALICS = EPA-designated NATTS Site

CELA is located on the rooftop of a two-story building northeast of downtown Los Angeles, just southeast of Dodgers' Stadium and Los Angeles State Historic Park, which are prominent features in Figure 6-1. CELA is surrounded by major freeways, including I-5 and Route 110. Highway 101 is located farther south. Although the area is classified as residential, a freight yard is located to the south of the site. The Los Angeles River runs north-south just east of the site. This monitoring site was originally set up as an emergency response monitoring site.

Figure 6-2 shows that CELA is situated among numerous point sources. The source category with the greatest number of emissions sources near this monitoring site is the airport source category, which includes airports and related operations as well as small runways and heliports, such as those associated with hospitals or television stations. Other source categories with a relatively large number of emissions sources within 10 miles of CELA include institutions such as schools, hospitals, and/or prisons; printing, publishing, and paper product manufacturing; and electroplating, plating, polishing, anodizing, and coloring facilities. A high-density cluster of emissions sources is located just to the west and southwest of CELA. The sources closest to CELA are a mineral processing facility, a facility involved in oil/gas production, and a heliport at a detention center.

RUCA is located just north of Riverside, in a residential area in the town of Rubidoux. RUCA is adjacent to a power substation next to a storage facility and apartment building near the intersection of Mission Boulevard and Riverview Drive. Residential areas surround RUCA, including three schools: a middle school north of Mission Boulevard, an elementary school south of Riverview Drive, and a high school to the west of Pacific Avenue, the football and baseball fields of which are prominent features in Figure 6-3. Highway 60 runs east-west to the north of the site. Flabob Airport is located approximately three-quarters of a mile to the southeast of the site. RUCA is located approximately 47 miles east of CELA.

Figure 6-4 shows that fewer emissions sources surround RUCA than CELA. Most of the emissions sources within 10 miles of RUCA are located to the northeast, north, and northwest of the site, in San Bernardino County. The point source located closest to RUCA is Flabob Airport and is the only source located within a half-mile of the site. Although the emissions source categories are varied, the emissions source categories with the greatest number of sources within 10 miles of RUCA include metals processing and fabrication; airport operations; institutions such as schools, hospitals, and/or prisons; and mines, quarries, and mineral processing facilities.

SJJCA is located in central San Jose. Figure 6-5 shows that SJJCA is located in a commercial area surrounded by residential areas. A railroad is shown east of the monitoring site, running north-south in Figure 6-5. Guadalupe Parkway (Route 87) intersects with I-880 approximately 1 mile northwest of the monitoring site. San Jose International Airport is just on the other side of this intersection. The Guadalupe River runs along the eastern boundary of the airport and runs parallel to the Guadalupe Parkway, as does the Guadalupe River Park and Gardens, a park and trail system which can be seen on the bottom left of Figure 6-5. Figure 6-6 shows that the density of point sources is significantly higher near SJJCA than the other California monitoring sites. The emissions source categories with the greatest number of sources surrounding SJJCA include electrical equipment manufacturing; auto body, paint, and automotive shops; institutions such as schools, hospitals, and/or prisons; and telecommunications/radio facility. Sources within a half-mile of SJJCA include a food processing facility, an auto body shop, and two sources in the miscellaneous source category.

In addition to providing city, county, CBSA, and land use/location setting information, Table 6-1 also contains traffic volume information for each site as well as the location for which the traffic volume was obtained. This information is provided because emissions from motor vehicles can significantly affect concentrations measured at a given monitoring site. CELA experiences a higher traffic volume compared to the other California sites, although the traffic volumes near each of these sites are all greater than 100,000. Compared to other NMP sites, CELA has the second highest traffic volume, RUCA ranks sixth, and SJJCA ranks ninth highest. The traffic volumes for CELA, RUCA and SJJCA were obtained from heavily traveled highways.

6.2 Pollutants of Interest

The risk-based screening process described in Section 3.2 was performed for each California site to identify site-specific "pollutants of interest," which allows analysts and readers to focus on a subset of pollutants through the context of risk. For each site, each pollutant's preprocessed daily measurement was compared to its associated risk screening value. If the concentration was greater than the risk screening value, then the concentration "failed the screen." The site-specific results of this risk-based screening process are presented in Table 6-2 and incorporate measurements from both 2015 and 2016. Pollutants of interest are those for which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens and are shaded in gray in Table 6-2. It is important to note which pollutants were sampled for at each site when reviewing the results of this analysis. PAHs were sampled for at all three California sites; in addition, metals (PM_{10}) were also sampled for at SJJCA.

Table 6-2. 2015-2016 Risk-Based Screening Results for the California Monitoring Sites

Pollutant	Screening Value ($\mu g/m^3$)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Los Angeles, California - CELA						
Naphthalene	0.029	115	118	97.46	98.29	98.29
Benzo(a)pyrene	0.00057	1	96	1.04	0.85	99.15
Fluorene	0.011	1	101	0.99	0.85	100.00
Total		117	315	37.14		
Rubidoux, California - RUCA						
Naphthalene	0.029	83	118	70.34	97.65	97.65
Benzo(a)pyrene	0.00057	2	87	2.30	2.35	100.00
Total		85	205	41.46		
San Jose, California - SJJCA						
Naphthalene	0.029	88	119	73.95	47.31	47.31
Arsenic (PM_{10})	0.00023	84	116	72.41	45.16	92.47
Nickel (PM_{10})	0.0021	11	116	9.48	5.91	98.39
Benzo(a)pyrene	0.00057	1	63	1.59	0.54	98.92
Cadmium (PM_{10})	0.00056	1	116	0.86	0.54	99.46
Lead (PM_{10})	0.015	1	116	0.86	0.54	100.00
Total		186	646	28.79		

Observations from Table 6-2 include the following:

- Concentrations of naphthalene failed the majority of screens for CELA, accounting for 115 of the 117 total failed screens for this site, while benzo(a)pyrene and fluorene concentrations failed a single screen each. Thus, naphthalene is the only pollutant identified as a pollutant of interest for CELA.

- Similarly, concentrations of naphthalene failed the majority of screens for RUCA, accounting for 83 of the 85 total failed screens for this site, while two concentrations of benzo(a)pyrene also failed screens. Thus, naphthalene is also the only pollutant identified as a pollutant of interest for RUCA. Note that the percentage of screens failed for naphthalene is higher for CELA (97 percent) than for RUCA (70 percent).

- Metals (PM_{10}) were also sampled for at SJJCA, in addition to PAHs. For SJJCA, concentrations of naphthalene also account for the most failed screens (88 of 186, or 47 percent), although arsenic concentrations contributed a similar number of failed screens (84). Together, these two pollutants account for more than 92 percent of SJJCA's total failed screens. Concentrations of nickel account for another 6 percent of the total failed screens for this site (11). Together, these three pollutants contribute to more than 95 percent of failed screens for SJJCA and were therefore identified as pollutants of interest for this site. Benzo(a)pyrene, cadmium, and lead also failed a single screen each for SJCCA but were not identified as pollutants of interest.

For each of the data analyses described in the remaining sections, the focus is on the site-specific pollutants of interest identified via the risk-based screening process, as described in Section 3.4.2.

6.3 Concentrations

This section presents various concentration averages used to characterize air toxics concentration levels at the California monitoring sites. Where applicable, the following calculations and data analyses were performed for each of the site-specific pollutants of interest:

- Time period-based concentration averages (quarterly and annual) are provided for each monitoring site for each year.

- The range of measurements and annual average concentrations are presented graphically for each site to illustrate how the site's concentrations compare to the program-level averages, as presented in Section 4.1.

- Concentration averages and other statistical metrics from 2015, 2016, and previous years of monitoring are presented in order to characterize concentration trends at each site.

Each data analysis is performed where the applicable criteria is met (as specified in the appropriate sections discussed below) and is limited to the site-specific pollutants of interest. However, site-specific statistical summaries for all pollutants sampled for at the California monitoring sites are provided in Appendices N and O.

6.3.1 2015 and 2016 Concentration Averages

Quarterly and annual concentration averages for 2015 and 2016 were calculated for the pollutants of interest for each California site, as described in Section 3.1. The *quarterly average concentration* of a particular pollutant is simply the average concentration of the preprocessed daily measurements over a given calendar quarter. Quarterly average concentrations include the substitution of zeros for all non-detects. A site must have a minimum of 75 percent valid samples compared to the total number of samples possible within a given calendar quarter for a quarterly average to be calculated. An *annual average concentration* includes all measured detections and substituted zeros for non-detects for an entire year of sampling. Annual averages were calculated for pollutants where three valid quarterly averages could be calculated for a given year and where method completeness was greater than or equal to 85 percent, as presented in Section 2.4. Quarterly and annual average concentrations for the pollutants of interest for the California monitoring sites are presented in Table 6-3, where applicable. Note that if a pollutant was not detected in a given calendar quarter, the quarterly average simply reflects “0” because only zeros substituted for non-detects were factored into the quarterly average concentration.

Table 6-3. Quarterly and Annual Average Concentrations of the Pollutants of Interest for the California Monitoring Sites

Pollutant	2015						2016					
	# of Detects/ # >MDL/ # Samples	Q1 Avg (ng/m^3)	Q2 Avg (ng/m^3)	Q3 Avg (ng/m^3)	Q4 Avg (ng/m^3)	Annual Average (ng/m^3)	# of Detects/ # >MDL/ # Samples	Q1 Avg (ng/m^3)	Q2 Avg (ng/m^3)	Q3 Avg (ng/m^3)	Q4 Avg (ng/m^3)	Annual Average (ng/m^3)
Los Angeles, California - CELA												
Naphthalene	57/57/57	91.18 ± 14.56	NA	59.11 ± 12.38	92.13 ± 20.41	76.85 ± 9.42	61/61/61	74.98 ± 15.21	61.14 ± 13.29	65.44 ± 16.02	111.65 ± 19.08	78.40 ± 9.06
Rubidoux, California - RUCA												
Naphthalene	59/59/59	56.35 ± 16.22	32.58 ± 10.08	32.09 ± 7.79	72.68 ± 17.91	48.70 ± 7.87	59/59/59	58.67 ± 15.61	39.37 ± 10.62	52.96 ± 16.50	101.27 ± 29.84	63.56 ± 11.03
San Jose, California - SJJCA												
Arsenic (PM_{10})	59/59/59	0.79 ± 0.27	0.42 ± 0.18	0.36 ± 0.16	0.48 ± 0.10	0.52 ± 0.10	57/57/57	0.52 ± 0.20	0.36 ± 0.10	0.51 ± 0.22	0.43 ± 0.19	0.45 ± 0.08
Naphthalene	58/58/58	78.13 ± 20.60	36.93 ± 9.63	44.92 ± 12.89	97.84 ± 23.16	65.13 ± 10.58	61/61/61	69.11 ± 21.63	34.99 ± 12.05	35.73 ± 10.30	77.09 ± 27.50	54.48 ± 10.29
Nickel (PM_{10})	59/59/59	1.97 ± 0.87	0.95 ± 0.16	1.32 ± 0.32	1.17 ± 0.35	1.36 ± 0.26	57/57/57	1.11 ± 0.34	1.31 ± 0.35	1.48 ± 0.35	1.25 ± 0.41	1.28 ± 0.17

NA = Not available because the criteria for calculating a quarterly and/or annual average were not met.

Observations for the California monitoring sites from Table 6-3 include the following:

- Naphthalene was identified as a pollutant of interest for all three sites. The annual average concentrations of naphthalene range from 48.70 ± 7.87 ng/m^3 (RUCA, 2015) to 78.40 ± 9.06 ng/m^3 (CELA, 2016); CELA has the highest annual average concentration of naphthalene for both years.

- For each site, naphthalene concentrations appear highest during the fourth quarters of each year, particularly for 2016, based on the quarterly averages shown. However, the confidence intervals calculated for each of these quarterly averages are relatively large, indicating that there is considerable variability in the measurements. Quarterly average concentrations vary considerably, varying the most for RUCA, which range from 32.09 ± 7.79 ng/m^3 (third quarter 2015) to 101.27 ± 29.84 ng/m^3 (fourth quarter 2016). CELA does not have a second quarter average concentration for naphthalene for 2015, as shown in Table 6-4. This is a result of issues with the collection system experienced throughout most of June 2015.

- Naphthalene concentrations measured at CELA across both years range from 10.9 ng/m^3 to 170 ng/m^3, with a median concentration of 73.00 ng/m^3. Naphthalene concentrations measured at RUCA range from 7.78 ng/m^3 to 181 ng/m^3, with a median concentration of 48.20 ng/m^3. Naphthalene concentrations measured at SJJCA range from 13.4 ng/m^3 to 205 ng/m^3, with a median concentration of 45.00 ng/m^3. Despite having the widest range of naphthalene concentrations measured and the only measurements (2) greater than 200 ng/m^3 among the California sites, SJJCA has the lowest median concentration of this pollutant. While the median concentrations for RUCA and SJJCA are fairly similar to each other, the median for CELA is considerably higher. The number of naphthalene concentrations greater than 100 ng/m^3 measured at CELA (33) is nearly twice the number measured at RUCA (17), with the number measured at SJJCA in between (21).

- At each California site, the highest concentrations of naphthalene were measured during the first or fourth quarters of either year, predominantly in January, February, November, or December. However, some of the lowest concentrations measured at CELA and RUCA, including the minimum concentrations, were also measured in December, helping to explain the large confidence intervals shown for these sites' fourth quarter naphthalene concentrations.

- Arsenic and nickel are also pollutants of interest for SJJCA. The quarterly and annual average concentrations of these pollutants are significantly less than those shown for naphthalene.

- Arsenic concentrations measured across both years at SJJCA range from 0.078 ng/m^3 to 2.02 ng/m^3. With the exception of the first quarter of 2015, the quarterly average concentrations do not vary considerably. The first quarter average for 2015 (0.79 ± 0.27 ng/m^3) is more than 0.25 ng/m^3 greater than the next highest quarterly average concentration for SJJCA. The first quarter of 2015 has the most arsenic measurements greater than 1 ng/m^3 (4), including the maximum concentration measured at this site. However, the confidence interval associated with this quarterly

average is the largest confidence interval shown in Table 6-3, indicating a relatively high level of variability in the measurements.

- Concentrations of nickel measured across both years at SJJCA range from 0.274 ng/m^3 to 6.10 ng/m^3. A review of the quarterly average concentrations shows that the first quarter average concentration for 2015 (1.97 ± 0.87 ng/m^3) is considerably higher than the others and has a relatively large confidence interval associated with it. The two highest nickel concentrations measured at SJJCA (6.10 ng/m^3 and 5.43 ng/m^3) were both measured in January 2015.

Tables 4-10 through 4-13 present the NMP sites with the 10 highest annual average concentrations for each of the program-level pollutants of interest. Observations for the California sites from those tables include the following:

- CELA is the only California site to appear in Table 4-12 for naphthalene, with its annual average concentrations ranking eighth (2016) and tenth (2015).

- SJJCA does not appear in Table 4-13 for PM_{10} metals.

6.3.2 Concentration Comparison

In order to better illustrate how each site's annual average concentrations compare to the program-level averages, a site-specific box plot was created for each of the site-specific pollutants of interest, where applicable. Thus, box plots were created for the pollutants listed in Table 6-3 for CELA, RUCA, and SJJCA. Figures 6-7 through 6-9 overlay the sites' minimum, annual average, and maximum concentrations for each year onto the program-level minimum, first quartile, median, average, third quartile, and maximum concentrations, as described in Section 3.4.2.1, and are discussed below. If an annual average concentration could not be calculated, the range of concentrations is still provided in the figures that follow.

Figure 6-7. Program vs. Site-Specific Average Arsenic (PM_{10}) Concentrations

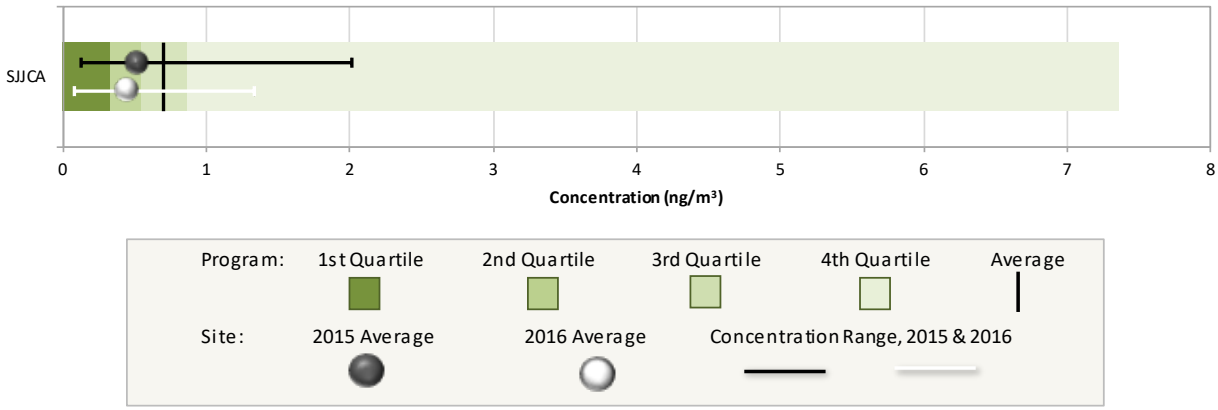


Figure 6-7 presents the box plot for arsenic (PM_{10}) for SJJCA and shows the following:

- The maximum arsenic concentrations measured each year at SJJCA are considerably less than the maximum concentration measured across the program.
- The range of arsenic concentrations measured at SJJCA in 2015 is larger than the range of concentrations measured in 2016.
- Both annual average arsenic concentrations calculated for SJJCA are less than the program-level average concentration (0.70 ng/m^3) and just less than the program-level median concentration of arsenic (0.55 ng/m^3).
- Non-detects of arsenic were not measured at SJJCA.

Figure 6-8. Program vs. Site-Specific Average Naphthalene Concentrations

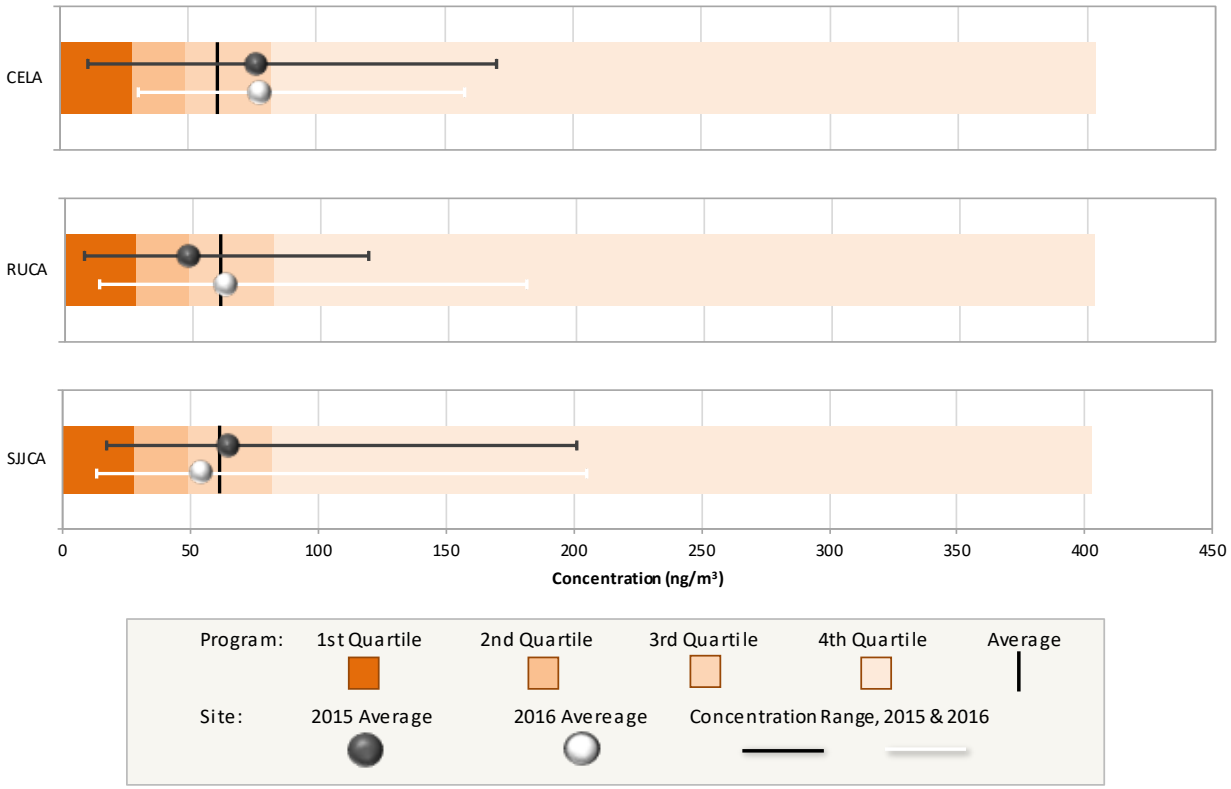


Figure 6-8 presents the box plots for naphthalene for all three sites and shows the following:

- Among the California sites, the highest naphthalene concentrations were measured at SJJCA. However, all of the naphthalene concentrations measured at these sites are considerably less than the maximum concentration measured across the program.
- CELA is the only California site for which both years' annual average concentrations are greater than the program-level average (61.23 ng/m^3); both annual averages are just less than the program-level third quartile (82.15 ng/m^3). Note that the minimum

concentration measured at CELA in 2016 is greater than the program-level first quartile.

- For RUCA and SJJCA, one year's annual average concentration is just greater than the program-level average and one year's annual average is less than the program-level average.

- There were no non-detects of naphthalene measured at CELA, RUCA, SJJCA, or across the program.

Figure 6-9. Program vs. Site-Specific Average Nickel (PM_{10}) Concentrations

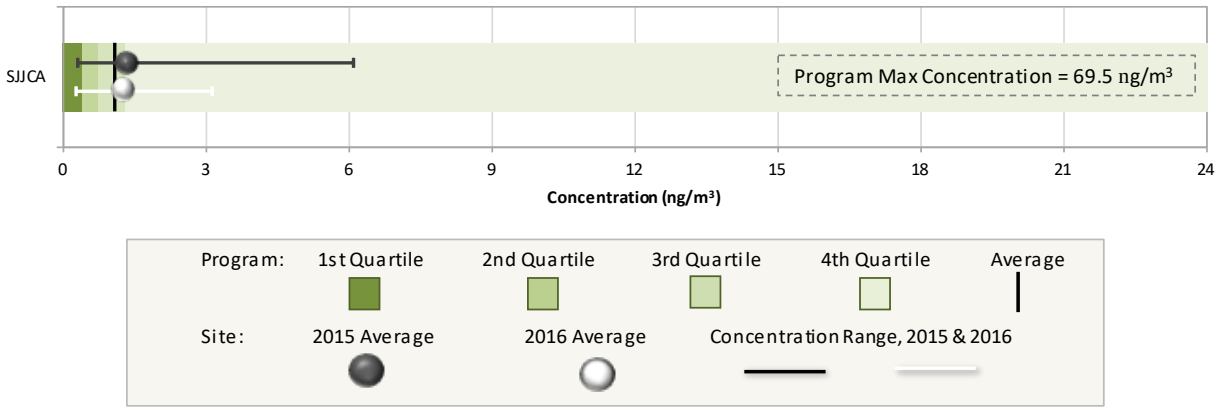


Figure 6-9 presents the box plot for nickel for SJJCA and shows the following:

- The program-level maximum nickel concentration (69.5 ng/m^3) is not shown directly on the box plot in Figure 6-9 because the scale of the box plot would be too large to readily observe data points at the lower end of the concentration range. Thus, the scale of the box plot has been reduced to 24 ng/m^3.

- The maximum nickel concentration measured across the program is more than 10 times greater than the maximum nickel concentration measured at SJJCA.

- The range of nickel concentrations measured at SJJCA in 2015 is approximately twice the range measured in 2016.

- Both of SJJCA's annual average nickel concentrations are greater than the program-level average concentration (1.09 ng/m^3), with the 2015 annual average concentration just greater than the program-level third quartile.

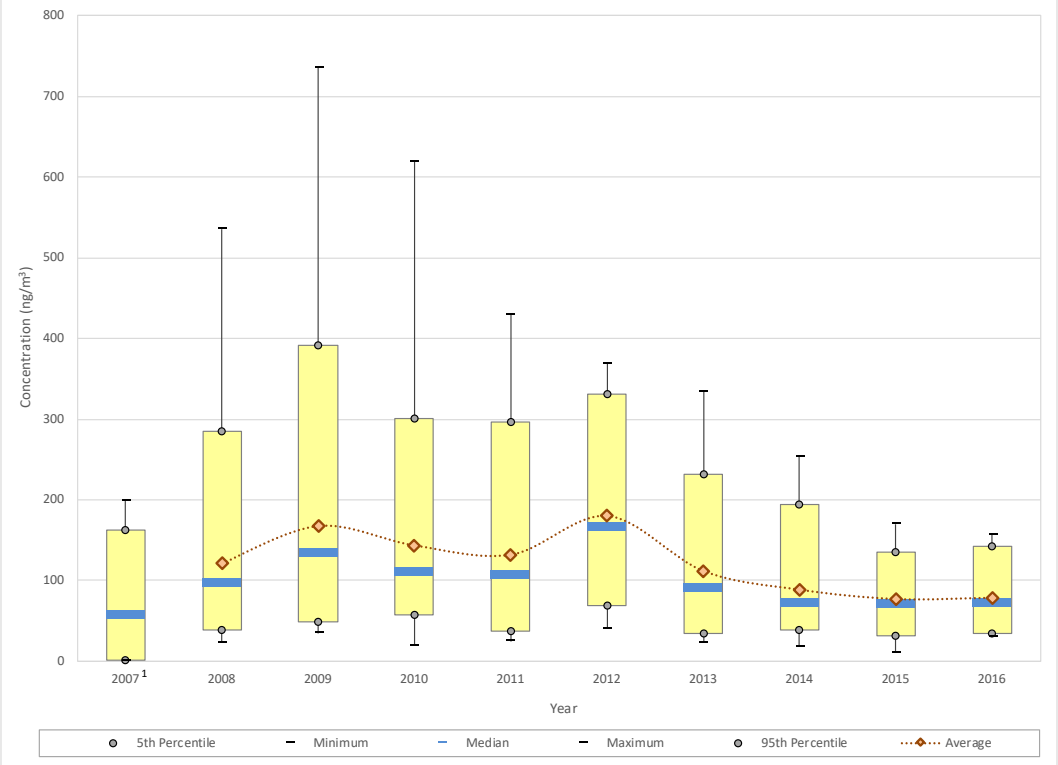
- Non-detects of nickel were not measured at SJJCA.

6.3.3 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the pollutants of interest for 5 consecutive years or longer, as described in Section 3.4.2.2. Both CELA and RUCA began sampling PAHs under the NMP in 2007. SJJCA began sampling

PAHs and metals under the NMP in 2008. Thus, Figures 6-10 through 6-14 present the 1-year statistical metrics for each of the pollutants of interest first for CELA, then for RUCA, and finally for SJJCA. The statistical metrics presented for assessing trends include the substitution of zeros for non-detects. If sampling began mid-year, a minimum of 6 months of sampling is required for inclusion in the trends analysis; in these cases, a 1-year average concentration is not provided, although the range and percentiles are still presented.

Figure 6-10. Yearly Statistical Metrics for Naphthalene Concentrations Measured at CELA



[1] A 1-year average is not presented because sampling under the NMP did not begin until April 2007.

Observations from Figure 6-10 for naphthalene concentrations measured at CELA include the following:

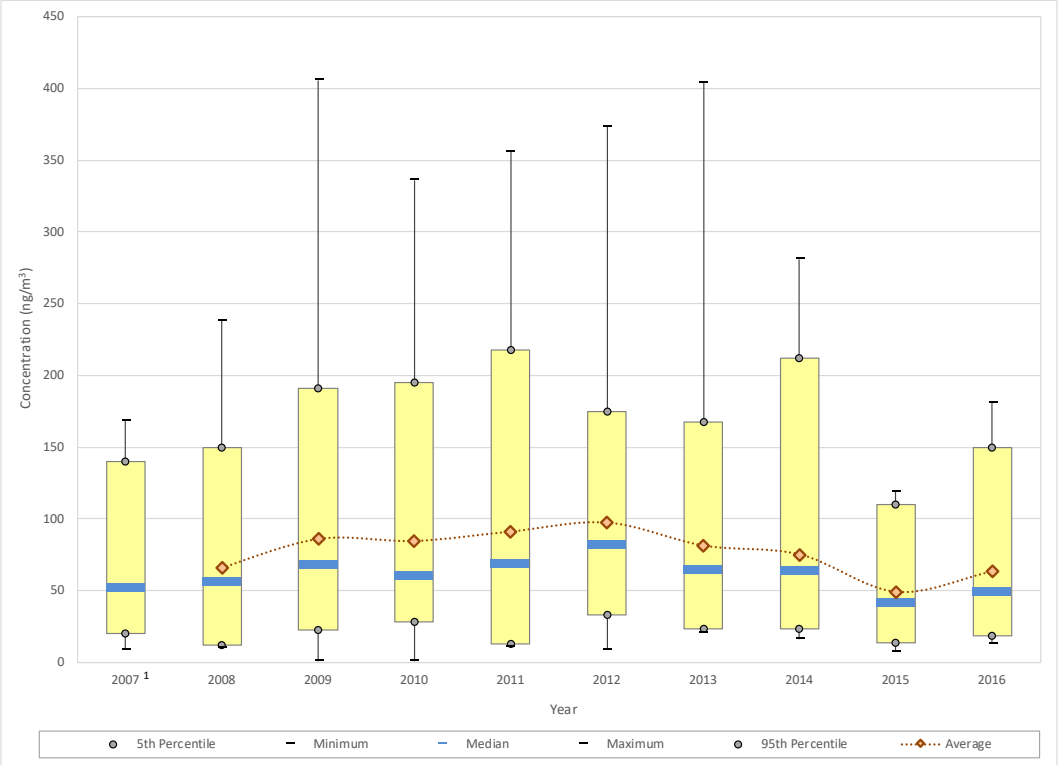
- CELA began sampling PAHs under the NMP in April 2007. Because a full year's worth of data is not available, a 1-year average concentration for 2007 is not presented, although the range of measurements is provided.

- The minimum concentration measured at CELA was measured in 2007 (1.30 ng/m^3); 2007 is the only year in which concentrations less than 10 ng/m^3 were measured (five in total). The range of naphthalene measurements increased considerably from 2007 to 2008 and again in 2009, when the maximum naphthalene concentration was measured (736 ng/m^3 on October 16, 2009). Concentrations greater than 500 ng/m^3 were also measured in 2008 and 2010. The maximum naphthalene concentration decreases steadily after 2009, with the smallest range of concentrations measured in 2016.

- All of the statistical parameters shown in Figure 6-10 exhibit an increase from 2011 to 2012 except the maximum concentration. The increase in the 1-year average concentration from 2011 to 2012 is significant, even though the range of concentrations measured in 2012 is the smallest since the onset of sampling. The number of naphthalene concentrations greater than 200 ng/m^3 increased from nine in 2011 to 24 for 2012, which is the most for any year of sampling at CELA.

- Each of the statistical metrics exhibits a decrease from 2012 to 2013, with the 1-year average concentration decreasing significantly (by nearly 40 percent). This decreasing trend continues through 2015, with little change shown for 2016. 2015 is the first year that a naphthalene concentration greater than 200 ng/m^3 was not measured at CELA.

Figure 6-11. Yearly Statistical Metrics for Naphthalene Concentrations Measured at RUCA



[1] A 1-year average is not presented because sampling under the NMP did not begin until May 2007.

Observations from Figure 6-11 for naphthalene concentrations measured at RUCA include the following:

- RUCA began sampling PAHs under the NMP in May 2007. Because a full year's worth of data is not available, a 1-year average concentration for 2007 is not presented, although the range of measurements is provided.

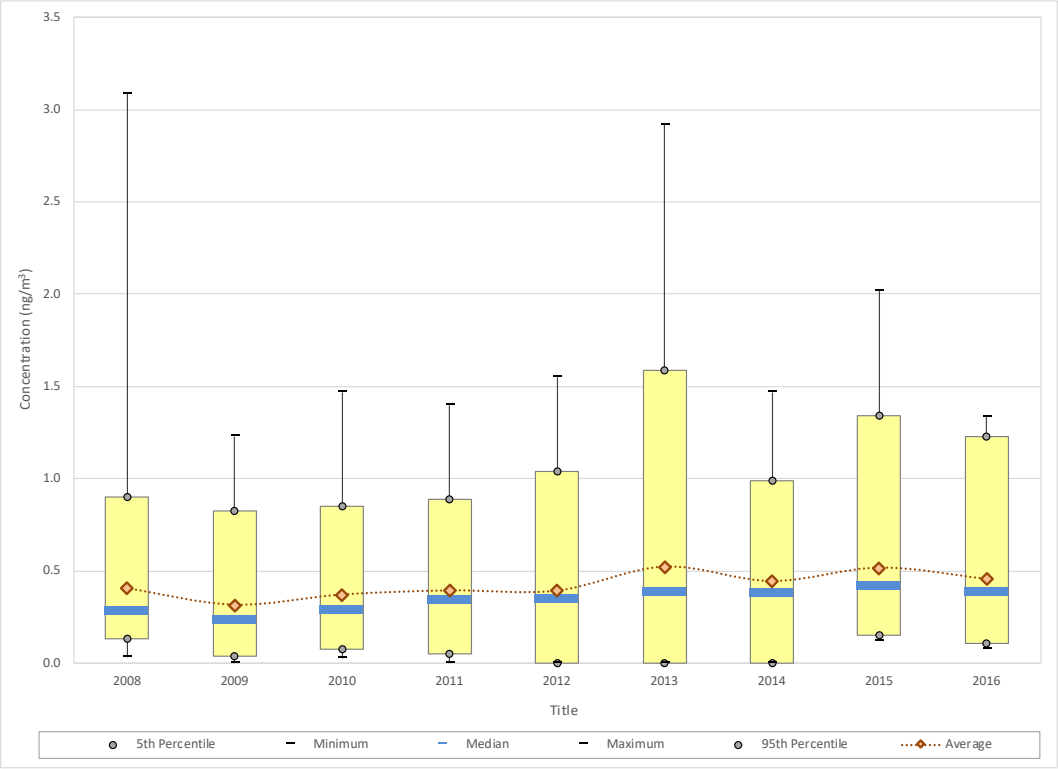
- The range of naphthalene concentrations measured increased through the early years of sampling at RUCA, in a similar manner to those measured at CELA. The maximum naphthalene concentration was measured at RUCA in 2009 (406 ng/m^3), although a concentration of similar magnitude was also measured at RUCA in 2013.

These are the only two naphthalene concentrations greater than 400 ng/m^3 measured at RUCA. Excluding 2009, the maximum concentration increases steadily between 2007 and 2013.

- The 1-year average concentration increases by more than 20 ng/m^3 from 2008 to 2009, changes little for 2010, then continues to increase slightly through 2012, reaching a maximum of nearly 100 ng/m^3. After 2012, 1-year average concentration begins to decrease, with the most significant decrease shown for 2015, when the 1-year average concentration is less than 50 ng/m^3 for the first (and only) time. The median concentration exhibits a similar pattern. All of the statistical parameters exhibit an increase from 2015 to 2016.

- Concentrations measured at RUCA in 2015 exhibit the least variability among the years of sampling. But the concentrations measured most years reflect a relatively high level of variability. For 2009, 2012, and 2013, the maximum concentration measured is twice the 95th percentile. For these years, more than 100 ng/m^3 separates the maximum concentration and the next highest concentration measured. In addition, concentrations less than 10 ng/m^3 have been measured during five year of sampling, including two measurements less than or equal to 1 ng/m^3.

Figure 6-12. Yearly Statistical Metrics for Arsenic (PM_{10}) Concentrations Measured at SJJCA



Observations from Figure 6-12 for arsenic concentrations measured at SJJCA include the following:

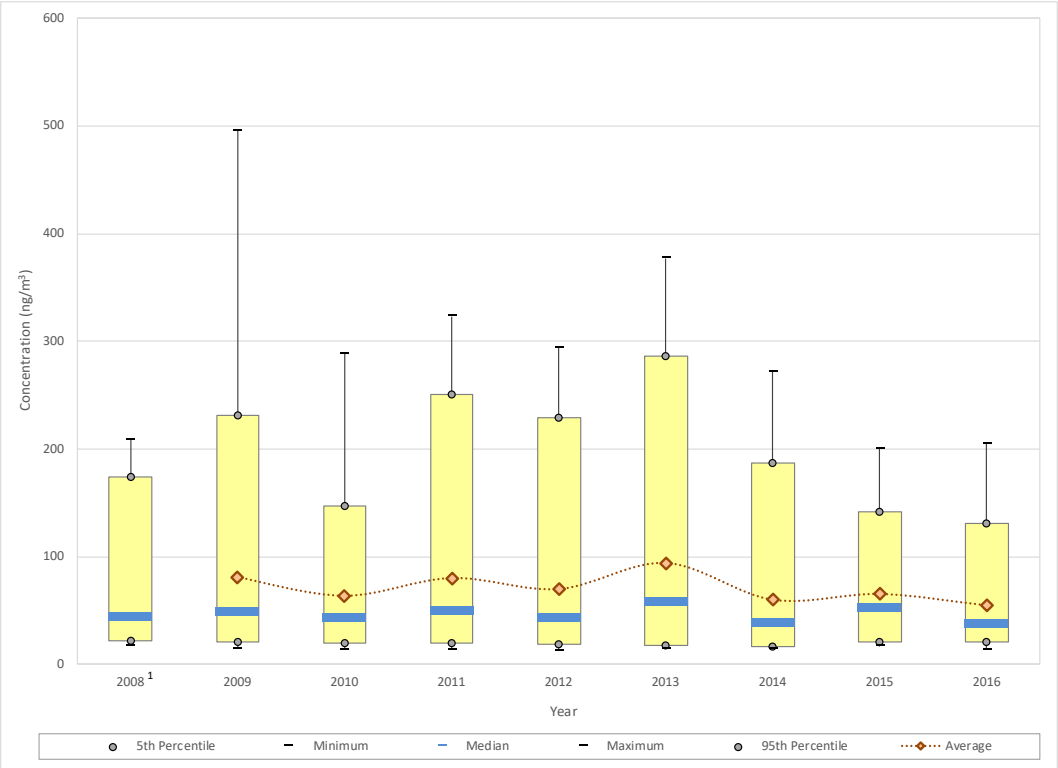
- The maximum concentration of arsenic (3.09 ng/m^3) was measured on the first day of sampling at SJJCA (January 1, 2008), though an arsenic concentration of similar magnitude was also measured in 2013 (2.92 ng/m^3). Only one other arsenic concentration greater than 2 ng/m^3 has been measured at SJJCA (2015).

- The 1-year average arsenic concentration decreased from 2008 to 2009. Although this is due in part to the magnitude of the maximum concentration measured in 2008, all of the statistical parameters exhibit a decrease from 2008 to 2009, indicating that the decrease is not only due to the difference in the maximum concentrations. The number of concentrations at the lower end of the concentration range increased for 2009. Seven arsenic concentrations less than 0.1 ng/m^3 were measured in 2009, compared to only two in 2008; in addition, two non-detects were measured at SJJCA in 2009, compared to none in 2008.

- Between 2010 and 2012, the range of arsenic concentrations measured changed little and the 1-year average concentration varied between 0.37 ng/m^3 for 2010 to 0.39 ng/m^3 for 2011 and 2012. With the exception of the minimum and 5th percentile (which did not change), each of the statistical metrics exhibit an increase for 2013, with the 1-year average concentration increasing to 0.52 ng/m^3. Along with the second highest concentration measured since the onset of sampling, the number of arsenic concentrations greater than 0.75 ng/m^3 measured at SJJCA increased to 16 for 2013, the most for any year of sampling thus far (none of the previous years had more than six).

- Between 2013 and 2016, the statistical parameters have a slight undulating pattern, with years of higher concentrations (and thus, higher 1-year average concentrations) following a year of lower concentrations. The median concentration for each of these years, though, varies by less than 0.04 ng/m^3.

Figure 6-13. Yearly Statistical Metrics for Naphthalene Concentrations Measured at SJJCA



[1] A 1-year average is not presented because sampling under the NMP did not begin until May 2008.

Observations from Figure 6-13 for naphthalene concentrations measured at SJJCA include the following:

- SJJCA began sampling PAHs under the NMP in May 2008. Because a full year's worth of data is not available, a 1-year average concentration for 2008 is not presented, although the range of measurements is provided.

- The maximum concentration of naphthalene was measured at SJJCA in 2009 (496 ng/m^3). No additional naphthalene concentrations greater than 400 ng/m^3 have been measured at SJJCA and few greater than 300 ng/m^3 have been measured at this site.

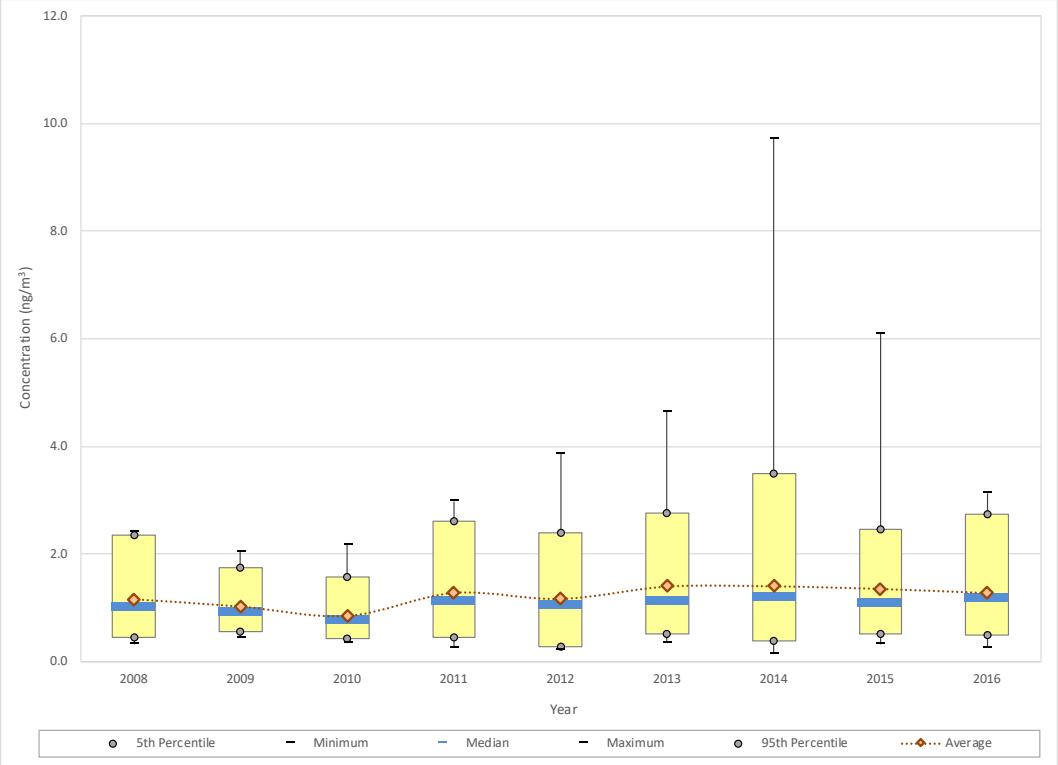
- There is very little change among the minimum concentrations and 5th percentiles across the years of sampling while there are considerable fluctuations in the statistical parameters representing the upper end of the concentration range, particularly between 2009 and 2014.

- The median concentration changed little over the years through 2012, ranging from 43.00 ng/m^3 (2010) to 49.90 ng/m^3 (2011). 2013 is the first year with a median concentration greater than 50 ng/m^3 (57.70 ng/m^3). For each year between 2013 and 2016, a median greater than 50 ng/m^3 is followed by a median less than 40 ng/m^3.

- The 1-year average concentration exhibits more variability, having an undulating pattern through 2014, ranging from 59.73 ng/m^3 (2014) to 94.13 ng/m^3 (2013) during this period. Between 2014 and 2016, the year-to-year changes are smaller

- Both the 1-year average and median concentrations are at a minimum for 2016.

Figure 6-14. Yearly Statistical Metrics for Nickel (PM_{10}) Concentrations Measured at SJJCA



Observations from Figure 6-14 for nickel concentrations measured at SJJCA include the following:

- The maximum concentration of nickel measured at SJJCA has a steady increasing trend after 2009, reaching a maximum of 9.73 ng/m^3 in 2014. The maximum concentration of nickel measured in 2014 is considerably higher than the next highest nickel concentration measured at this site (6.10 ng/m^3 measured in 2015).

- Both the 1-year average and median concentrations have a significant decreasing trend between 2008 and 2010, when both statistical parameters are at a minimum for the period of sampling. This is followed by a significant increase for 2011. The number of nickel concentrations greater than 1 ng/m^3 more than doubled from 2010 (16) to 2011 (37).

- The changes in the 1-year average and median concentrations have been more subtle in more recent years. After a slight decrease for 2012, both central tendency parameters increased for 2013. Between 2013 and 2016, the median concentration has varied by only 0.10 ng/m^3 and the 1-year average concentration has varied by less

than 0.15 ng/m^3, despite the changes in the maximum concentration and 95th percentile shown.

6.4 Additional Risk-Based Screening Evaluations

The following risk-based screening evaluations were conducted to characterize risk related to the air toxics measured at each California monitoring site. Refer to Sections 3.2, 3.4.2.3, and 3.4.2.4 for definitions and explanations regarding the various toxicity factors, time frames, and calculations associated with these risk-based screenings.

6.4.1 Cancer Risk and Noncancer Hazard Approximations

For the pollutants of interest for the California monitoring sites, risk was examined by calculating cancer risk and noncancer hazard approximations for each year annual average concentrations could be calculated. These approximations can be used as risk estimates for cancer and noncancer effects attributable to the pollutants of interest. Although the use of these approximations is limited, they may help identify where policy-makers want to shift their air monitoring priorities. Refer to Section 3.4.2.3 for an explanation of how cancer risk and noncancer hazard approximations are calculated and what limitations are associated with them. Annual averages, cancer UREs and/or noncancer RfCs, and cancer risk and noncancer hazard approximations are presented in Table 6-4, where applicable. Cancer risk approximations are presented as probabilities while the noncancer hazard approximations are ratios and thus, unitless values.

Observations for the California sites from Table 6-4 include the following:

- Annual average concentrations of naphthalene range from 48.70 ± 7.87 ng/m^3 (RUCA, 2015) to 78.40 ± 9.06 ng/m^3 (CELA, 2016). All of the cancer risk approximations for naphthalene are less than 3 in-a-million, ranging from 1.66 in-a-million (RUCA, 2015) to 2.67 in-a-million (CELA, 2016). All of the noncancer hazard approximations for naphthalene are considerably less than 1.0 (all are less than an HQ of 0.05).

- SJJCA is the only California site with pollutants of interest other than naphthalene. The cancer risk approximations for arsenic for both years are similar to the cancer risk approximations calculated for naphthalene each year for SJJCA, while the cancer risk approximations for nickel are both less than 1 in-a-million.

- The noncancer hazard approximations for arsenic and nickel for SJJCA are also considerably less than 1.0, similar to those calculated for naphthalene, indicating that no adverse noncancer health effects are expected from these individual pollutants.

Table 6-4. Risk Approximations for the California Monitoring Sites

Pollutant	Cancer URE ($\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	2015				2016			
			# of Measured Detections vs. # of Samples	Annual Average (ng/m^3)	Risk Approximations		# of Measured Detections vs. # of Samples	Annual Average (ng/m^3)	Risk Approximations	
					Cancer (in-a-million)	Noncancer (HQ)			Cancer (in-a-million)	Noncancer (HQ)
Los Angeles, California - CELA										
Naphthalene	0.000034	0.003	57/57	76.85 ± 9.42	2.61	0.03	61/61	78.40 ± 9.06	2.67	0.03
Rubidoux, California - RUCA										
Naphthalene	0.000034	0.003	59/59	48.70 ± 7.87	1.66	0.02	59/59	63.56 ± 11.03	2.16	0.02
San Jose, California - SJJC										
Arsenic (PM_{10})	0.0043	0.000015	59/59	0.52 ± 0.10	2.21	0.03	57/57	0.45 ± 0.08	1.95	0.03
Naphthalene	0.000034	0.003	58/58	65.13 ± 10.58	2.21	0.02	61/61	54.48 ± 10.29	1.85	0.02
Nickel (PM_{10})	0.00048	0.00009	59/59	1.36 ± 0.26	0.65	0.02	57/57	1.28 ± 0.17	0.61	0.01

-- = A Cancer URE or Noncancer RfC is not available.

6.4.2 Risk-Based Emissions Assessment

In addition to the risk-based screening discussed above, this section presents an evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 6-5 presents the 10 pollutants with the highest emissions from the 2014 NEI (version 1) that have cancer toxicity factors. Table 6-5 also presents the 10 pollutants with the highest toxicity-weighted emissions, based on the weighting schema described in Section 3.4.2.4. Lastly, Table 6-5 provides the pollutants of interest with the highest cancer risk approximations (in-a-million) for each site, as presented in Table 6-4. Cancer risk approximations for 2015 are presented in green while approximations for 2016 are in white. The emissions, toxicity-weighted emissions, and cancer risk approximations are shown in descending order in Table 6-5. Table 6-6 presents similar information, but is limited to those pollutants with noncancer toxicity factors.

Because not all pollutants have both cancer and noncancer toxicity factors, the highest emitted pollutants in the cancer table may be different from the noncancer table, although the actual quantity of emissions is the same. The cancer risk and noncancer hazard approximations based on each site's annual averages are limited to the pollutants of interest identified for each site. In addition, the cancer risk and noncancer hazard approximations are limited to those pollutants with enough data to meet the criteria for annual averages to be calculated. A more in-depth discussion of this analysis is provided in Section 3.4.2.4. Similar to the cancer risk and noncancer hazard approximations provided in Section 6.4.1, this analysis may help policy-makers prioritize their air monitoring activities.

Observations from Table 6-5 include the following:

- Formaldehyde and benzene are the highest emitted pollutants with cancer UREs in Los Angeles, Riverside, and Santa Clara Counties. The quantity of emissions for the pollutants shown is considerably greater for Los Angeles County than Riverside and Santa Clara Counties.

- Formaldehyde has the highest toxicity-weighted emissions (of the pollutants with cancer UREs) for Los Angeles County, followed by POM, Group 1a, and hexavalent chromium. These same pollutants have the highest toxicity-weighted emissions for Riverside and Santa Clara Counties but the order varies, with hexavalent chromium ranking first for both counties.

- Six of the highest emitted pollutants in Los Angeles County also have the highest toxicity-weighted emissions, while there are eight in common for Riverside County and seven in common for Santa Clara County. Despite the relatively high ranking for hexavalent chromium for each county's toxicity-weighted emissions, this pollutant does not appear among the highest pollutants emitted in each county.

- Naphthalene, which is a pollutant of interest for all three sites, appears on both emissions-based lists for all three counties.

- While arsenic and nickel do not appear among the highest emitted pollutants in Santa Clara County (they rank lower than tenth), they rank seventh and ninth, respectively, for their toxicity-weighted emissions.

Observations from Table 6-6 include the following:

- Toluene is the highest emitted pollutant with a noncancer RfC in all three California counties. The quantity emitted is significantly higher for Los Angeles County than Riverside and Santa Clara Counties.

- Acrolein and chlorine are the pollutants with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) for all three counties. Although these two pollutants rank highest for toxicity-weighted emissions for each county, neither pollutant appears among the highest emitted.

- Three of the highest emitted pollutants also have the highest toxicity-weighted emissions for Los Angeles and Riverside Counties, while only two of the highest emitted pollutants also have the highest toxicity-weighted emissions for Santa Clara County.

- Naphthalene is the only pollutant of interest for CELA. Naphthalene does not appear among the highest emitted pollutants (of those with a noncancer RfC) for Los Angeles County, although it does rank tenth for its toxicity-weighted emissions. A similar observation can be made for RUCA and SJJCA, where naphthalene's toxicity-weighted emissions rank among the highest for both Riverside and Santa Clara Counties (ranking seventh highest for both counties) but this pollutant does not appear among the highest emitted.

- Arsenic and nickel are also pollutants of interest for SJJCA. Similar to naphthalene, these two pollutants appear among those with the highest toxicity-weighted emissions for Santa Clara County, but not among the highest emitted. Lead, which was sampled for at SJJCA and but was not identified as a pollutant of interest, also appears among those with the highest toxicity-weighted emissions in Table 6-6. Concentrations of lead failed a single screen for SJJCA.

Table 6-5. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the California Monitoring Sites

Top 10 Total Emissions for Pollutants with Cancer UREs (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Los Angeles, California (Los Angeles County) - CELA					
Formaldehyde	1,720.49	Formaldehyde	2.24E-02	Naphthalene	2.67
Benzene	1,565.85	POM, Group 1a	1.89E-02	Naphthalene	2.61
Dichloromethane	1,379.64	Hexavalent Chromium, PM	1.61E-02		
Acetaldehyde	700.59	Ethylene oxide	1.26E-02		
Ethylbenzene	622.36	Benzene	1.22E-02		
1,3-Butadiene	274.82	1,3-Butadiene	8.24E-03		
p-Dichlorobenzene	238.30	Naphthalene	4.64E-03		
POM, Group 1a	215.10	*p*-Dichlorobenzene	2.62E-03		
Naphthalene	136.42	Nickel, PM	2.48E-03		
Tetrachloroethylene	57.81	POM, Group 5a	1.85E-03		
Rubidoux, California (Riverside County) - RUCA					
Formaldehyde	390.30	Hexavalent Chromium, PM	9.95E-03	Naphthalene	2.16
Benzene	314.48	Formaldehyde	5.07E-03	Naphthalene	1.66
Dichloromethane	172.55	POM, Group 1a	4.02E-03		
Acetaldehyde	156.68	Benzene	2.45E-03		
Ethylbenzene	136.34	1,3-Butadiene	1.98E-03		
1,3-Butadiene	66.12	Naphthalene	1.31E-03		
p-Dichlorobenzene	52.30	*p*-Dichlorobenzene	5.75E-04		
POM, Group 1a	45.69	Nickel, PM	5.67E-04		
Naphthalene	38.45	Acetaldehyde	3.45E-04		
1,3-Dichloropropene	17.12	Ethylbenzene	3.41E-04		

[1]Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Table 6-5. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the California Monitoring Sites (Continued)

Top 10 Total Emissions for Pollutants with Cancer UREs (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
San Jose, California (Santa Clara County) - SJJCA					
Formaldehyde	243.18	Hexavalent Chromium, PM	3.74E-03	Arsenic	2.21
Benzene	227.20	POM, Group 1a	3.25E-03	Naphthalene	2.21
Acetaldehyde	151.12	Formaldehyde	3.16E-03	Arsenic	1.95
Ethylbenzene	106.49	Benzene	1.77E-03	Naphthalene	1.85
Dichloromethane	90.81	Naphthalene	1.66E-03	Nickel	0.65
Bis(2-ethylhexyl) phthalate, gas	69.83	1,3-Butadiene	1.54E-03	Nickel	0.61
1,3-Butadiene	51.26	Arsenic, PM	5.36E-04		
Naphthalene	48.73	*p*-Dichlorobenzene	4.83E-04		
p-Dichlorobenzene	43.93	Nickel, PM	3.91E-04		
POM, Group 1a	36.95	Acetaldehyde	3.32E-04		

[1]Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Table 6-6. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the California Monitoring Sites

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Hazard Approximation (HQ)**
Los Angeles, California (Los Angeles County) - CELA					
Toluene	5,286.05	Acrolein	4,082,251.24	Naphthalene	0.03
1,1,1-Trichloroethane	3,400.41	Chlorine	642,408.04	Naphthalene	0.03
Xylenes	2,683.77	Cyanide Compounds, PM	199,875.63		
Methanol	2,187.37	Formaldehyde	175,560.45		
Formaldehyde	1,720.49	1,3-Butadiene	137,409.43		
Benzene	1,565.85	Manganese, PM	103,247.72		
Dichloromethane	1,379.64	Acetaldehyde	77,843.69		
Hexane	1,167.71	Nickel, PM	57,307.96		
Acetaldehyde	700.59	Benzene	52,195.08		
Ethylbenzene	622.36	Naphthalene	45,474.14		
Rubidoux, California (Riverside County) - RUCA					
Toluene	1,072.19	Acrolein	782,148.33	Naphthalene	0.02
Xylenes	574.60	Chlorine	96,879.61	Naphthalene	0.02
1,1,1-Trichloroethane	407.00	Formaldehyde	39,826.03		
Formaldehyde	390.30	1,3-Butadiene	33,058.33		
Methanol	375.60	Acetaldehyde	17,409.28		
Benzene	314.48	Nickel, PM	13,127.70		
Hexane	288.62	Naphthalene	12,816.64		
Dichloromethane	172.55	Lead, PM	11,794.83		
Styrene	169.01	Benzene	10,482.56		
Acetaldehyde	156.68	Hexavalent Chromium, PM	8,289.97		

[1]Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Table 6-6. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the California Monitoring Sites (Continued)

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Hazard Approximation (HQ)**
San Jose, California (Santa Clara County) - SJJCA					
Toluene	628.93	Acrolein	684,804.86	Arsenic	0.03
Xylenes	409.19	Chlorine	118,671.89	Arsenic	0.03
Methanol	293.38	2,4-Toluene diisocyanate	85,429.29	Naphthalene	0.02
Formaldehyde	243.18	1,3-Butadiene	25,631.72	Naphthalene	0.02
Benzene	227.20	Formaldehyde	24,814.38	Nickel	0.02
Hexane	173.95	Acetaldehyde	16,791.50	Nickel	0.01
Ethylene glycol	165.72	Naphthalene	16,243.44		
Acetaldehyde	151.12	Nickel, PM	9,059.86		
1,1,1-Trichloroethane	118.67	Lead, PM	8,632.37		
Ethylbenzene	106.49	Arsenic, PM	8,310.91		

[1]Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

6.5 Summary of the 2015-2016 Monitoring Data for the California Monitoring Sites

Results from several of the data analyses described in this section include the following:

- *Naphthalene failed the most screens for all three California sites and thus, was identified as a pollutant of interest for each of them. Two additional PM_{10} metals were identified as pollutants of interest for SJJCA, the only California site at which PM_{10} metals were sampled.*

- *CELA has the highest annual average concentrations of naphthalene among the California monitoring sites. CELA's annual averages of naphthalene are among the highest calculated for NMP sites sampling PAHs.*

- *Naphthalene concentrations have a decreasing trend at CELA in recent years. This is also true for RUCA through 2015, but concentrations exhibit an increase for 2016.*

- *None of the pollutants of interest for the California sites have cancer risk approximations greater than 3 in-a-million; none of the pollutants of interest for the California sites have noncancer hazard approximations greater than an HQ of 1.0.*

7.0 Sites in Colorado

This section summarizes those data from samples collected at the NATTS and UATMP sites in Colorado and generated by ERG, EPA's contract laboratory for the NMP, over the 2015 and 2016 monitoring efforts. This section also examines the spatial and temporal characteristics of the ambient monitoring concentrations and reviews them through the context of risk. Readers are encouraged to refer to Sections 1 through 4 for detailed discussions and definitions regarding the various data analyses presented below.

> Data generated by sources other than ERG, EPA's contract laboratory for the NMP, are not included in the data analyses contained in this report.

7.1 Site Characterization

This section characterizes the Colorado monitoring sites by providing a description of the nearby area surrounding each monitoring site; plotting emissions sources surrounding the monitoring sites; and presenting traffic data and other characterizing information for each site. This information is provided to give the reader insight regarding factors that may influence the air quality near the sites and assist in the interpretation of the ambient monitoring measurements.

The Colorado NATTS site is in Grand Junction (GPCO) while the six UATMP sites are in neighboring Garfield County, in the towns of Battlement Mesa (BMCO), Silt (BRCO), Parachute (PACO), Carbondale (RFCO), Glenwood Springs (GSCO), and Rifle (RICO). Figure 7-1 for GPCO presents a composite satellite image retrieved from ArcGIS Explorer showing the monitoring site and its immediate surroundings. Figure 7-2 identifies nearby point source emissions locations by source category, as reported in the 2014 NEI for point sources, version 1. Note that only sources within 10 miles of GPCO are included in the facility counts provided in Figure 7-2. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have a direct effect on the air quality at the monitoring site. Further, this boundary provides both the proximity of emissions sources to the monitoring site as well as the quantity of such sources within a given distance of the site. Sources outside the 10-mile boundary are still visible on the map for reference but have been grayed out to emphasize emissions sources within the boundary. Figures 7-3 through 7-10 are the composite satellite maps and emissions sources maps for the Garfield County sites. Table 7-1 provides supplemental geographical information such as land use, location setting, and locational coordinates. Each figure and table is discussed in detail in the paragraphs that follow.

Figure 7-1. Grand Junction, Colorado (GPCO) Monitoring Site

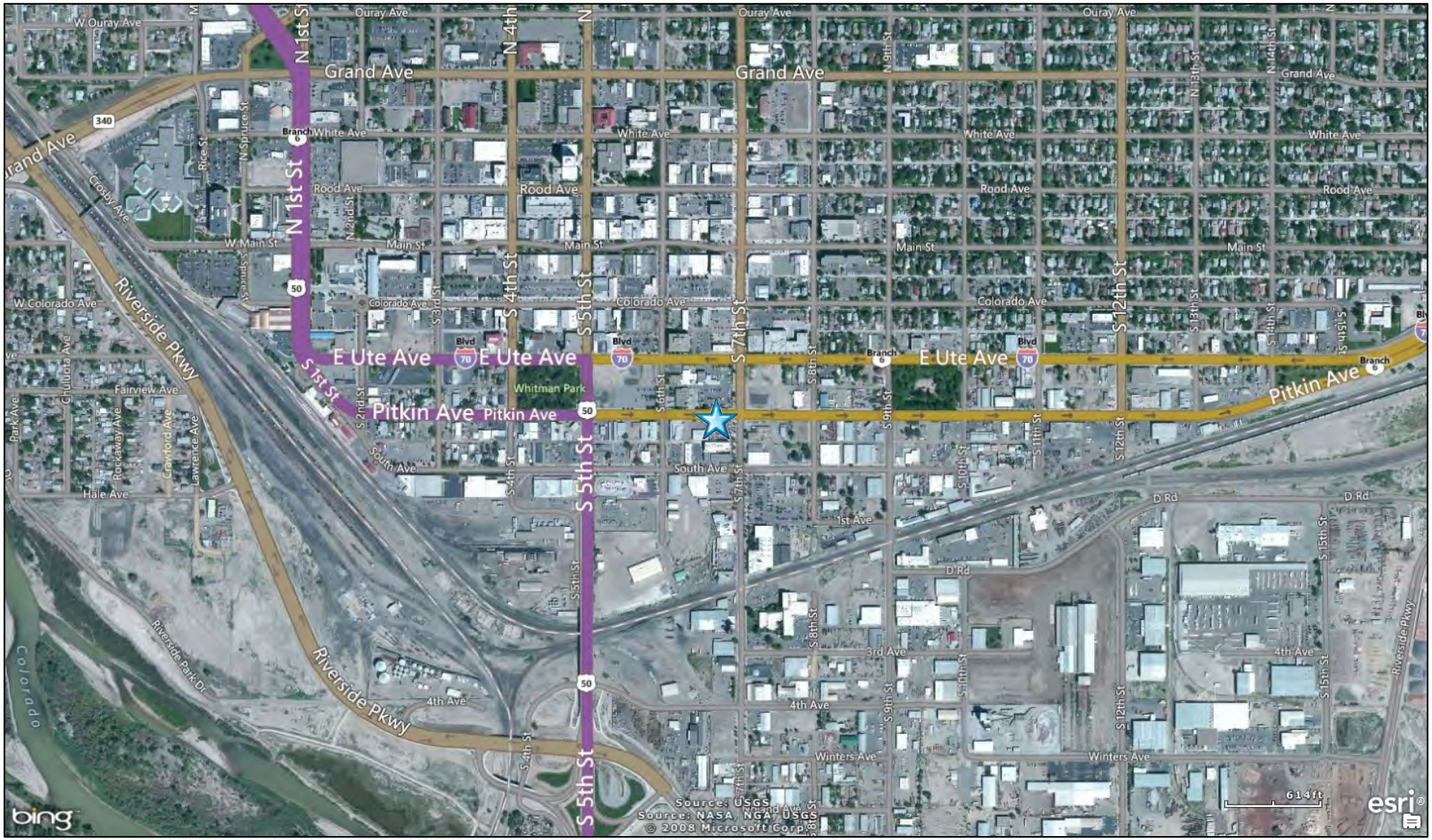


Figure 7-2. NEI Point Sources Located Within 10 Miles of GPCO

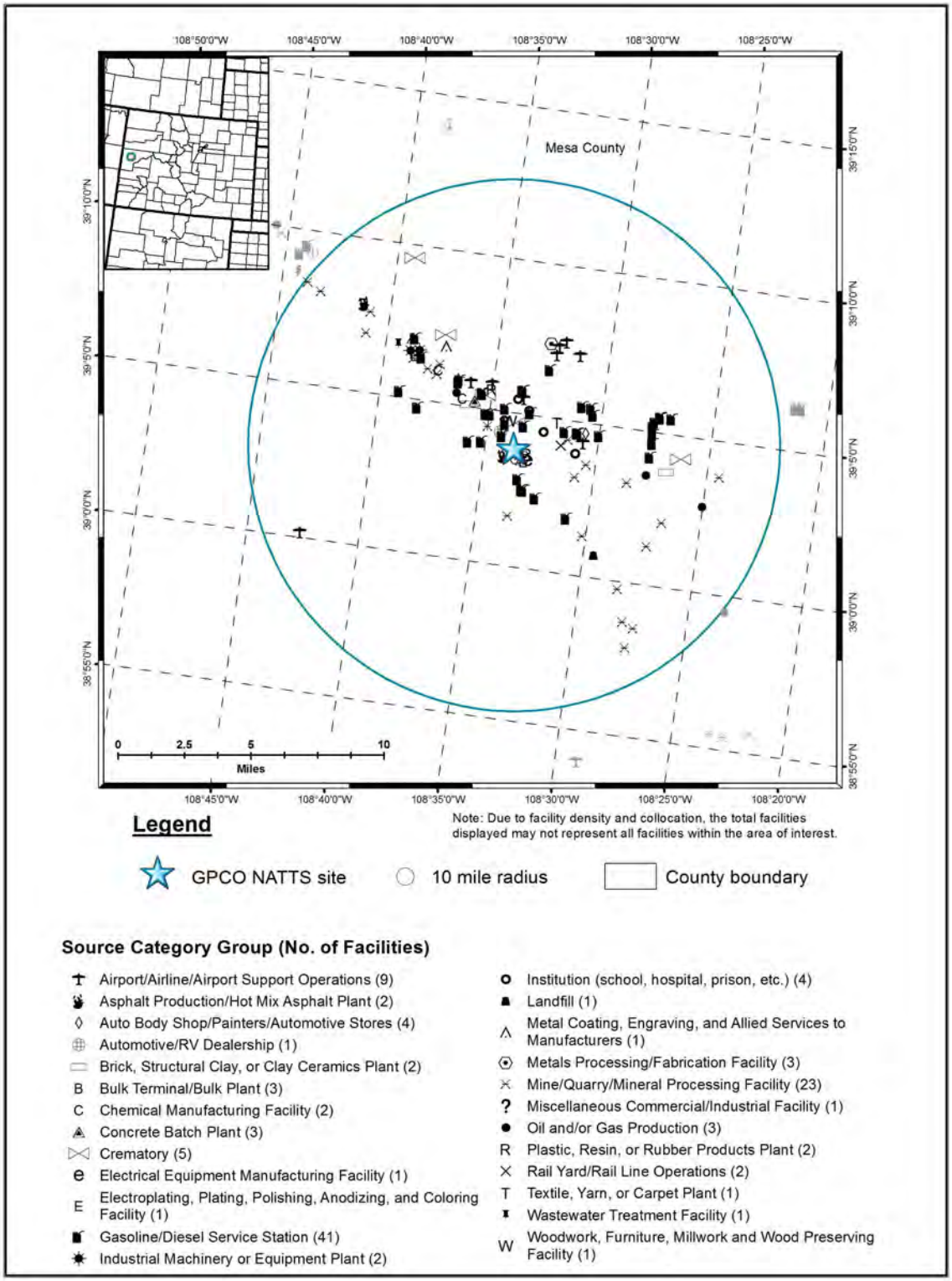


Figure 7-3. Battlement Mesa, Colorado (BMCO) Monitoring Site

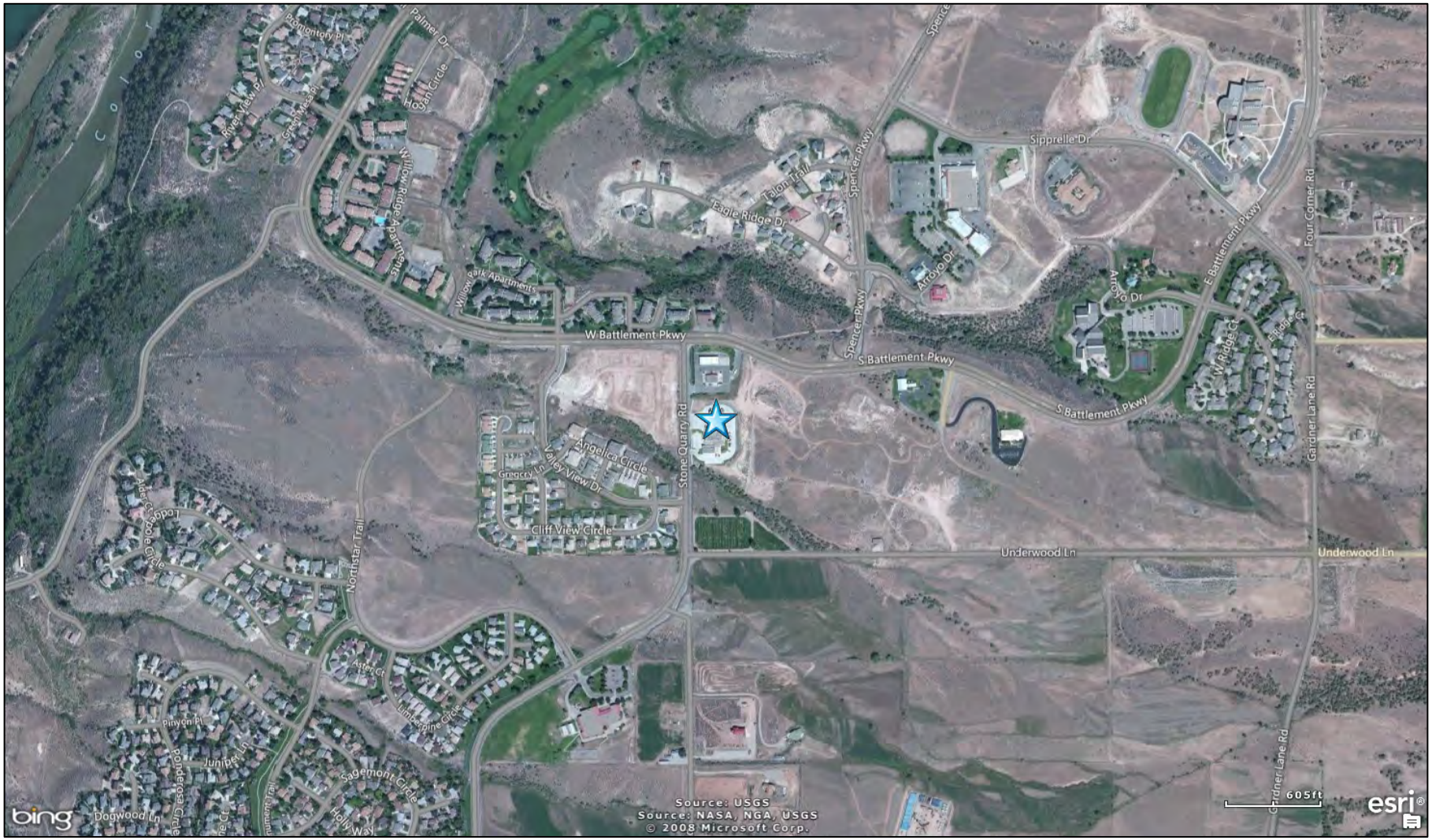


Figure 7-4. Silt, Colorado (BRCO) Monitoring Site

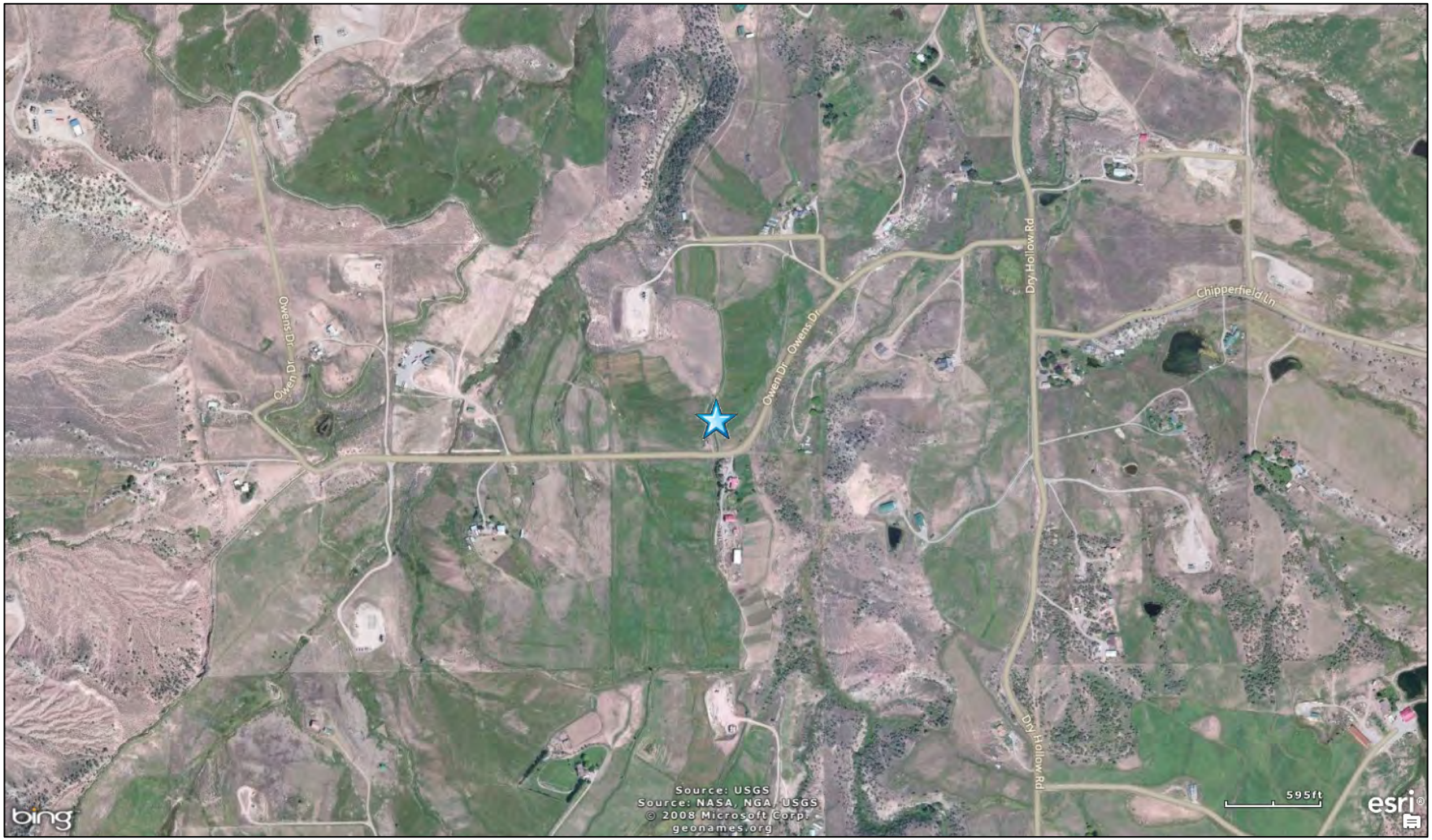


Figure 7-5. Parachute, Colorado (PACO) Monitoring Site

Figure 7-6. Rifle, Colorado (RICO) Monitoring Site

Figure 7-7. NEI Point Sources Located Within 10 Miles of BMCO, BRCO, PACO, and RICO

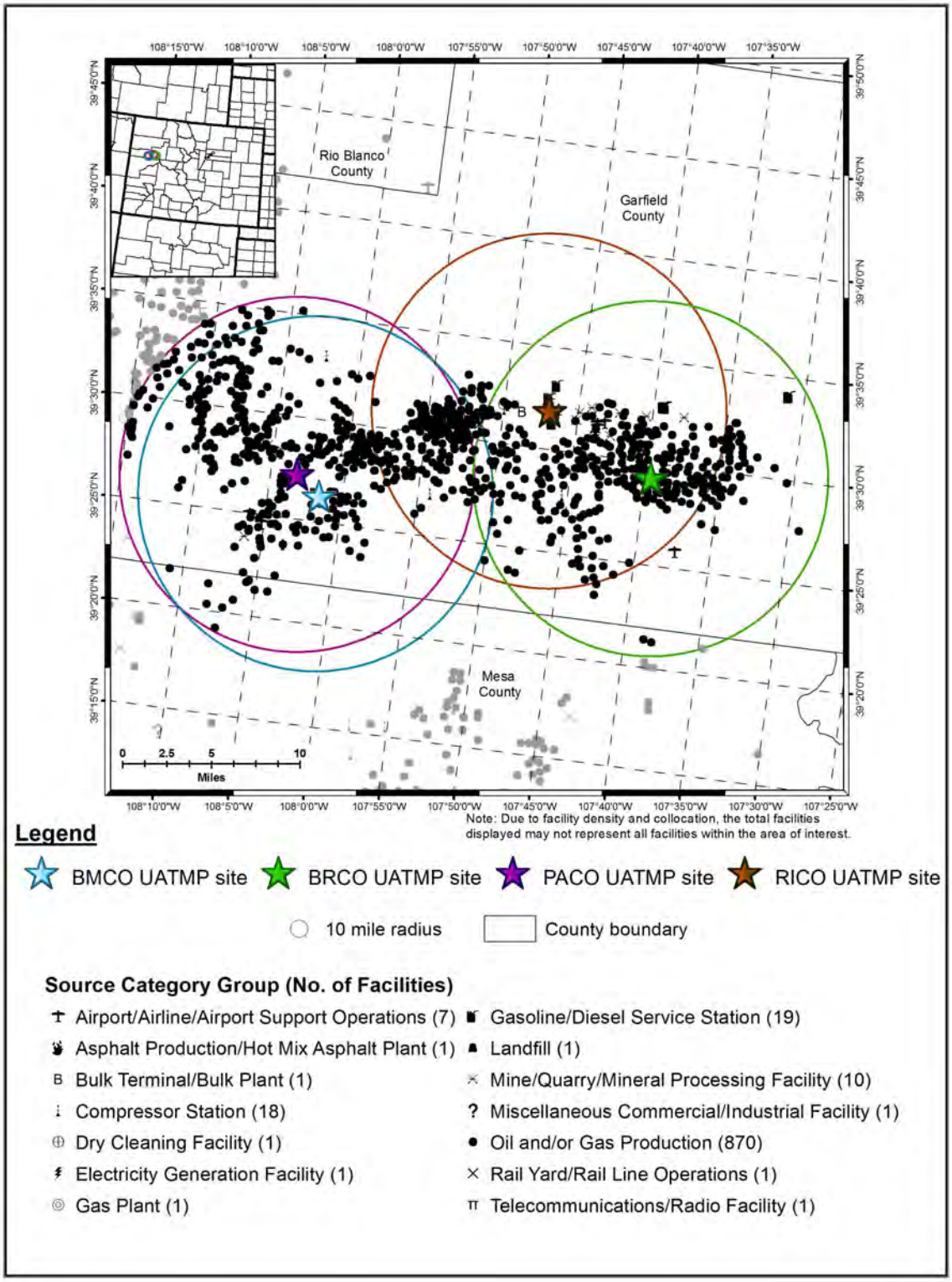


Figure 7-8. Glenwood Springs, Colorado (GSCO) Monitoring Site

Figure 7-9. Carbondale, Colorado (RFCO) Monitoring Site

Figure 7-10. NEI Point Sources Located Within 10 Miles of GSCO and RFCO

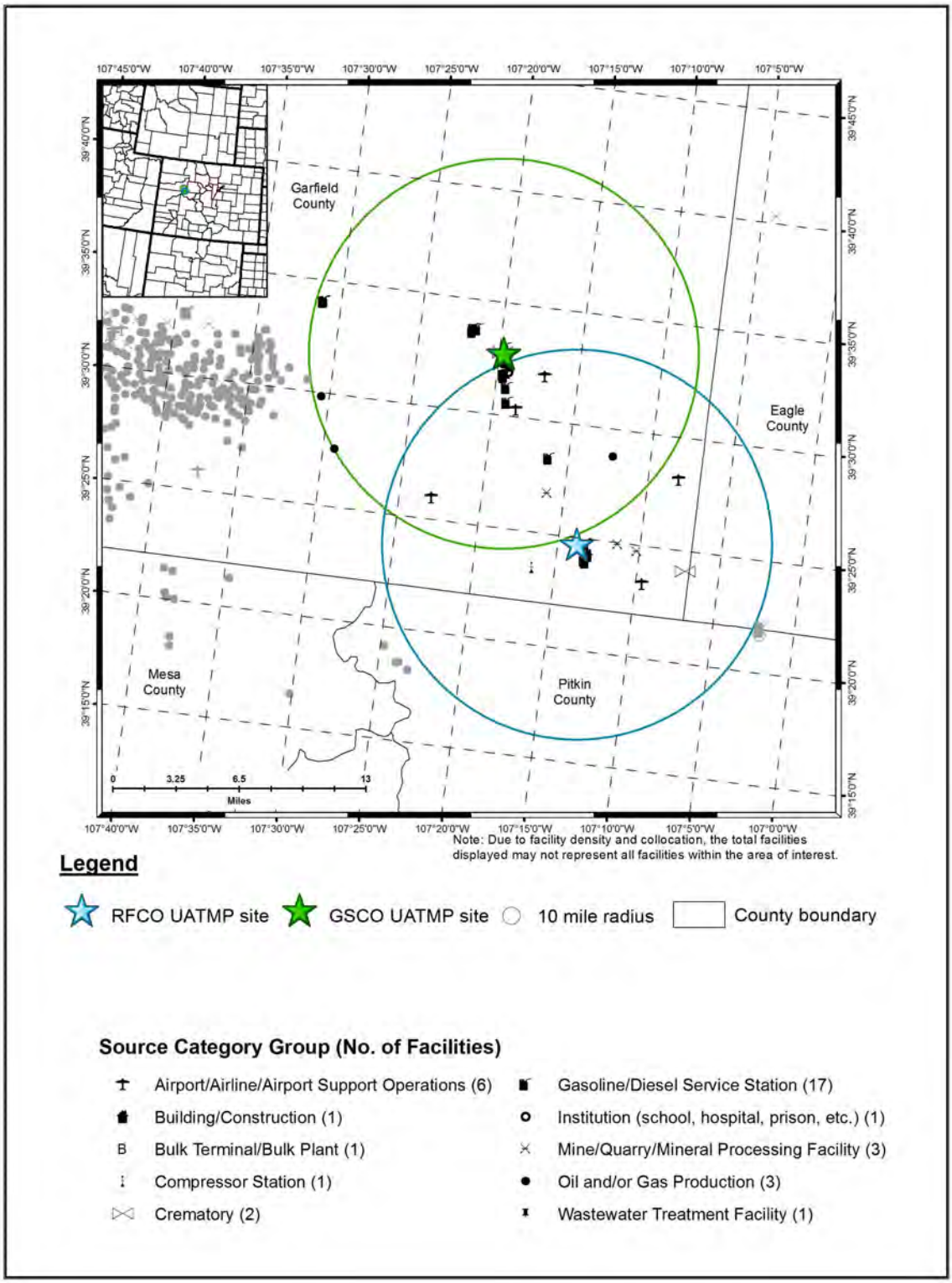


Table 7-1. Geographical Information for the Colorado Monitoring Sites

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Annual Average Daily Traffic[1]	Intersection Used for Traffic Data
GPCO	08-077-0017 08-077-0018	Grand Junction	Mesa	Grand Junction, CO	39.064289, -108.561550	Commercial	Urban/City Center	12,000	Bus-70 (Pitkin Ave) just E of 7th St
BMCO	08-045-0019	Battlement Mesa	Garfield	Glenwood Springs, CO	39.438060, -108.026110	Commercial	Suburban	1,880	S Battlement Pkwy
BRCO	08-045-0009	Silt	Garfield	Glenwood Springs, CO	39.487755, -107.659685	Agricultural	Rural	1,182	Dry Hollow Rd
PACO	08-045-0005	Parachute	Garfield	Glenwood Springs, CO	39.453654, -108.053259	Residential	Urban/City Center	17,000	I-70 near exit 75
RICO	08-045-0007	Rifle	Garfield	Glenwood Springs, CO	39.531813, -107.782298	Commercial	Urban/City Center	16,000	Rte 13 connecting US-6 and I-70
GSCO	08-045-0020	Glenwood Springs	Garfield	Glenwood Springs, CO	39.5464, -107.3286	Commercial	Suburban	27,000	Hwy 82/Grand Ave, south of 6th St
RFCO	08-045-0018	Carbondale	Garfield	Glenwood Springs, CO	39.412278, -107.230397	Residential	Rural	18,000	Rte 133 just south of Hwy 82

[1]AADT reflects 2015 data for GPCO, PACO, GSCO RFCO, and RICO (CO DOT, 2015) and 2014 data for BMCO and BRCO (GCRBD, 2014)

BOLD ITALICS = EPA-designated NATTS Site

The GPCO monitoring site is comprised of two locations. The first location is a small 1-story shelter that houses the VOC and carbonyl compound collection systems, with the PAH collection system located just outside the shelter. The second location, which is on the roof of an adjacent 2-story building, is comprised of the metals collection systems. As a result, two AQS codes are provided in Table 7-1. Figure 7-1 shows that the area surrounding GPCO is of mixed usage, with commercial businesses to the west, northwest, and north; residential areas to the northeast and east; and industrial areas to the southeast, south, and southwest. This site's location is next to a major east-west roadway (I-70 Business) in central Grand Junction. A rail line runs northeast-southwest a few blocks to the south of the GPCO monitoring site, and merges with another rail line to the southwest of the site. The Colorado River can be seen in the bottom left-hand corner of Figure 7-1 near the junction with the Gunnison River. Grand Junction is located in the Grand Valley, which lies north and northeast of the Colorado National Monument.

As Figure 7-2 shows, GPCO is located within 10 miles of numerous emissions sources. Many of the sources are located along a diagonal line running roughly northwest to southeast along Highways 6 and 50 and Business-70 and oriented along the mountain valley. Many of the point sources near GPCO fall into the gasoline/diesel service station or the mine/quarry/mineral processing source categories. The sources closest to GPCO (within a half-mile) are a bulk terminal/bulk plant, a gasoline/diesel service station, and an auto body shop.

There are six monitoring sites located in the eastern half of Garfield County; four of the six Garfield County monitoring sites are situated in towns located within a river valley along the Colorado River and paralleling I-70. The BMCO monitoring site is located in Battlement Mesa, a rural community located to the east and southeast of Parachute. The monitoring site is located on the roof of the Grand Valley Fire Protection District facility, near the intersection of Stone Quarry Road and West Battlement Parkway, as shown in Figure 7-3. Developed property around the site is primarily residential subdivisions, although a gas station is located immediately to the north of the site and a cemetery is located to the south.

The BRCO monitoring site is located on Bell/Melton Ranch, off Owens Drive, approximately 4 miles south of the town of Silt. The site is both rural and agricultural in nature. As shown in Figure 7-4, the closest major roadway is County Road 331, Dry Hollow Road.

PACO is located on the roof of the old Parachute High School building, which is presently operating as an early education facility. This location is in the center of the town of

Parachute. The surrounding area is considered residential. Interstate-70 is less than a quarter of a mile from the monitoring site, as shown in Figure 7-5. PACO is located approximately 1.8 miles from BMCO; these are the two sites in Garfield County that are the closest to each other.

RICO is located on the roof of the Henry Annex Building in downtown Rifle. This location is near the crossroads of several major roadways through town, as shown in Figure 7-6. Highway 13 and US-6/24 intersect just south of RICO and I-70 is just over a half-mile south of the monitoring site, across the Colorado River. The surrounding area is commercial in nature.

These four Garfield County sites are located along a line running roughly east-west and spanning approximately 20 miles; hence, they are shown together in Figure 7-7. These four sites lie within an area with high oil and gas related activity. There are nearly 900 petroleum or natural gas wells (collectively shown as the oil and/or gas production source category) within 10 miles of these sites. Garfield County is collecting SNMOC samples to characterize the effects these wells may have on the air quality in the surrounding areas (GCPH, 2015). There are also numerous gasoline/diesel service stations, mine/quarry/mineral processing facilities, and compressor stations within 10 miles of these sites.

The instrumentation at BMCO was moved to a new location, GSCO, in February 2015. The GSCO site is located in Glenwood Springs, which is one of the easternmost towns in Garfield County along the I-70 corridor. GSCO is located at Vogelaar Park, adjacent to Glenwood Springs Elementary School. This monitoring site is in a commercial area, with town government buildings to the northeast, a decommissioned wastewater treatment facility to the north (GCPH, 2017) and a church to the west. This location is also near the confluence of the Colorado River with the Roaring Fork River, which are prominent features along the top and center of Figure 7-8. I-70 is located about a quarter-mile north of GSCO. After 13 months of sampling, the instrumentation returned to the BMCO location.

Approximately 11 miles south of Glenwood Springs is Carbondale, where RFCO is located. The RFCO monitoring site is the only site in Garfield County not located along the I-70 corridor. The town of Carbondale resides in the Roaring Fork Valley (GCA, 2016), between the Roaring Fork and Crystal Rivers, north of Mt. Sopris (Carbondale, 2017). The RFCO monitoring site is located near the boathouse of the Rocky Mountain School on the bank of the Crystal River in the northern part of town. The surrounding area is residential and rural in nature. Highway 82, which runs southward from Glenwood Springs and separates Carbondale from the base of Red

Hill, is just over one-third of a mile north of RFCO and is visible in the top right-hand corner of Figure 7-9.

The emissions sources surrounding the sites in the Roaring Fork Valley are provided in a separate map in Figure 7-10. This figure shows that GSCO and RFCO are located outside the oil and gas fields of Garfield County. The emissions source category with the most sources within 10 miles of these sites is the gasoline and/or diesel service stations category. Within a half-mile of GSCO are a crematory, a waste water treatment facility, a bulk terminal/bulk plant, and two gasoline/diesel service stations. There are no emissions sources located within a half-mile of RFCO; the closest emissions source is a gasoline/diesel service station.

In addition to providing city, county, CBSA, and land use/location setting information, Table 7-1 also contains traffic volume information for each site as well as the location for which the traffic volume was obtained. This information is provided because emissions from motor vehicles can significantly affect concentrations measured at a given monitoring site. Among the Colorado sites, the traffic volume for BRCO is the lowest while the traffic volume is highest near GSCO. The traffic volumes near RICO, RFCO, PACO, GSCO, and GPCO are considerably higher than the traffic volumes near BMCO and BRCO, which have some of the lowest traffic volumes among NMP sites. Yet, the traffic volumes for all seven Colorado sites rank in the bottom half compared to the traffic volumes for other NMP sites.

7.2 Pollutants of Interest

The risk-based screening process described in Section 3.2 was performed for each monitoring site to identify site-specific "pollutants of interest," which allows analysts and readers to focus on a subset of pollutants through the context of risk. For each site, each pollutant's preprocessed daily measurement was compared to its associated risk screening value. If the concentration was greater than the risk screening value, then the concentration "failed the screen." The site-specific results of this risk-based screening process are presented in Table 7-2 and incorporate measurements from both 2015 and 2016, where applicable. Pollutants of interest are those for which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens and are shaded in gray in Table 7-2. It is important to note which pollutants were sampled for at each site when reviewing the results of this analysis. VOCs, carbonyl compounds, PM_{10} metals, and PAHs were sampled for at GPCO while SNMOCs and carbonyl compounds were sampled for at each of the Garfield County sites except RFCO. Between January and September 2015, canister samples collected at RFCO were analyzed for

both VOCs and SNMOCs, after which only SNMOCs were analyzed for the rest of 2015, as well as throughout 2016.

Table 7-2. 2015-2016 Risk-Based Screening Results for the Colorado Monitoring Sites

Pollutant	Screening Value ($\mu g/m^3$)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Grand Junction, Colorado - GPCO						
Acetaldehyde	0.45	114	114	100.00	11.94	11.94
Formaldehyde	0.077	114	114	100.00	11.94	23.87
Naphthalene	0.029	114	116	98.28	11.94	35.81
Benzene	0.13	112	112	100.00	11.73	47.54
1,3-Butadiene	0.03	111	112	99.11	11.62	59.16
Carbon Tetrachloride	0.17	111	112	99.11	11.62	70.79
1,2-Dichloroethane	0.038	98	99	98.99	10.26	81.05
Arsenic (PM_{10})	0.00023	65	117	55.56	6.81	87.85
Ethylbenzene	0.4	29	112	25.89	3.04	90.89
Acenaphthene	0.011	17	113	15.04	1.78	92.67
Dichloromethane	60	14	112	12.50	1.47	94.14
Fluoranthene	0.011	14	116	12.07	1.47	95.60
Hexachloro-1,3-butadiene	0.045	10	14	71.43	1.05	96.65
Benzo(a)pyrene	0.00057	9	111	8.11	0.94	97.59
Fluorene	0.011	8	102	7.84	0.84	98.43
p-Dichlorobenzene	0.091	5	45	11.11	0.52	98.95
1,2-Dibromoethane	0.0017	4	4	100.00	0.42	99.37
Bromomethane	0.5	3	112	2.68	0.31	99.69
Trichloroethylene	0.2	2	19	10.53	0.21	99.90
Acenaphthylene	0.011	1	93	1.08	0.10	100.00
Total		955	1849	51.65		
Battlement Mesa, Colorado - BMCO						
Benzene	0.13	54	54	100.00	58.06	58.06
Formaldehyde	0.077	27	27	100.00	29.03	87.10
Acetaldehyde	0.45	12	27	44.44	12.90	100.00
Total		93	108	86.11		
Silt, Colorado - BRCO						
Benzene	0.13	109	109	100.00	60.89	60.89
Formaldehyde	0.077	49	54	90.74	27.37	88.27
Acetaldehyde	0.45	19	54	35.19	10.61	98.88
1,3-Butadiene	0.03	2	2	100.00	1.12	100.00
Total		179	219	81.74		

Table 7-2. 2015-2016 Risk-Based Screening Results for the Colorado Monitoring Sites (Continued)

Pollutant	Screening Value (µg/m^3)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Glenwood Springs, Colorado - GSCO						
Benzene	0.13	64	64	100.00	46.72	46.72
Formaldehyde	0.077	31	31	100.00	22.63	69.34
1,3-Butadiene	0.03	25	27	92.59	18.25	87.59
Acetaldehyde	0.45	17	31	54.84	12.41	100.00
Total		137	153	89.54		
Parachute, Colorado - PACO						
Benzene	0.13	108	108	100.00	55.10	55.10
Formaldehyde	0.077	46	47	97.87	23.47	78.57
Acetaldehyde	0.45	32	46	69.57	16.33	94.90
1,3-Butadiene	0.03	9	9	100.00	4.59	99.49
Ethylbenzene	0.4	1	106	0.94	0.51	100.00
Total		196	316	62.03		
Carbondale, Colorado - RFCO						
Benzene	0.13	51	51	100.00	53.13	53.13
Carbon Tetrachloride	0.17	20	20	100.00	20.83	73.96
1,2-Dichloroethane	0.038	18	19	94.74	18.75	92.71
1,3-Butadiene	0.03	7	7	100.00	7.29	100.00
Total		96	97	98.97		
Rifle, Colorado - RICO						
Benzene	0.13	106	106	100.00	34.42	34.42
1,3-Butadiene	0.03	77	77	100.00	25.00	59.42
Formaldehyde	0.077	56	56	100.00	18.18	77.60
Acetaldehyde	0.45	46	55	83.64	14.94	92.53
Ethylbenzene	0.4	23	107	21.50	7.47	100.00
Total		308	401	76.81		

Observations from Table 7-2 include the following:

- The number of pollutants failing screens varied significantly between GPCO and the Garfield County monitoring sites; this is expected given the difference in pollutants measured at the sites.

- Concentrations of 20 pollutants failed at least one screen for GPCO; 52 percent of the concentrations for these 20 pollutants were greater than their associated risk screening value (or failed screens). GPCO ranks third for the number of pollutants failing screens, behind only NBIL (23 pollutants), BTUT and S4MO (22 each), and tying PXSS with 20.

- Twelve pollutants contributed to 95 percent of failed screens for GPCO and therefore were identified as pollutants of interest for GPCO. These 12 include two carbonyl compounds, six VOCs, three PAHs, and one PM_{10} metal.

- The number of pollutants failing screens for the Garfield County sites range from three (BMCO) to five (PACO and RICO). Benzene failed screens for each Garfield County site. 1,3-Butadiene also failed screens at four of the six sites (BMCO and BRCO are the exceptions). Formaldehyde and acetaldehyde failed screens for each site sampling carbonyl compounds.

- For four of the six Garfield County sites (BMCO, GSCO, RFCO, RICO) all of the pollutants that failed screens were also identified as site-specific pollutants of interest. For BRCO and PACO, one pollutant was excluded from this designation.

- Benzene failed 100 percent of screens for all seven Colorado sites.

- Carbonyl compound samples were collected on a 1-in-12 day sampling schedule at BMCO, BRCO, GSCO, PACO, and RICO, while SNMOC samples were collected on a 1-in-6 day sampling schedule; thus, the number of carbonyl compound samples collected at these sites were often less than half the number of SNMOC samples collected. At RFCO, the concurrent VOC and SNMOC sampling frequency appears more variable because site operators were collecting make-up samples for a number of invalid samples, after which, a 1-in-12 day sampling schedule resumed.

For each of the data analyses described in the remaining sections, the focus is on the site-specific pollutants of interest identified via the risk-based screening process, as described in Section 3.4.2.

7.3 Concentrations

This section presents various concentration averages used to characterize air toxics concentration levels at the Colorado monitoring sites. Where applicable, the following calculations and data analyses were performed for each of the site-specific pollutants of interest:

- Time period-based concentration averages (quarterly and annual) are provided for each monitoring site for each year.

- The range of measurements and annual average concentrations are presented graphically for each site to illustrate how the site's concentrations compare to the program-level averages, as presented in Section 4.1.

- Concentration averages and other statistical metrics for 2015, 2016, and from previous years of monitoring are presented in order to characterize concentration trends at each site.

Each data analysis is performed where the applicable criteria are met (as specified in the appropriate sections discussed below) and is limited to the site-specific pollutants of interest.

However, site-specific statistical summaries for all pollutants sampled for at the Colorado monitoring sites are provided in Appendices J, K, M, N, and O.

7.3.1 2015 and 2016 Concentration Averages

Quarterly and annual concentration averages for 2015 and 2016 were calculated for the pollutants of interest for each Colorado monitoring site, as described in Section 3.1. The *quarterly average concentration* of a particular pollutant is simply the average concentration of the preprocessed daily measurements over a given calendar quarter. Quarterly average concentrations include the substitution of zeros for all non-detects. A site must have a minimum of 75 percent valid samples compared to the total number of samples possible within a given calendar quarter for a quarterly average to be calculated. An *annual average concentration* includes all measured detections and substituted zeros for non-detects for an entire year of sampling. Annual averages were calculated for pollutants where three valid quarterly averages could be calculated for a given year and where method completeness was greater than or equal to 85 percent, as presented in Section 2.4. Quarterly and annual average concentrations for the pollutants of interest for the Colorado monitoring sites are presented in Table 7-3, where applicable. Note that concentrations of the PAHs and metals for GPCO are presented in ng/m^3 for ease of viewing. Also note that if a pollutant was not detected in a given calendar quarter, the quarterly average simply reflects "0" because only zeros substituted for non-detects were factored into the quarterly average concentration.

Table 7-3. Quarterly and Annual Average Concentrations of the Pollutants of Interest for the Colorado Monitoring Sites

Pollutant	2015						2016					
	# of Detects/ # >MDL/ # Samples	Q1 Avg (µg/m³)	Q2 Avg (µg/m³)	Q3 Avg (µg/m³)	Q4 Avg (µg/m³)	Annual Average (µg/m³)	# of Detects/ # >MDL/ # Samples	Q1 Avg (µg/m³)	Q2 Avg (µg/m³)	Q3 Avg (µg/m³)	Q4 Avg (µg/m³)	Annual Average (µg/m³)
Grand Junction, Colorado - GPCO												
Acetaldehyde	55/55/55	NA	1.54 ± 0.38	1.51 ± 0.18	1.67 ± 0.27	1.63 ± 0.17	59/59/59	1.52 ± 0.20	1.72 ± 0.31	2.06 ± 0.33	1.95 ± 0.38	1.81 ± 0.15
Benzene	50/50/50	NA	0.60 ± 0.06	0.91 ± 0.39	NA	NA	62/62/62	1.00 ± 0.23	0.53 ± 0.06	0.51 ± 0.11	0.86 ± 0.14	0.71 ± 0.09
1,3-Butadiene	50/49/50	NA	0.09 ± 0.01	0.10 ± 0.02	NA	NA	62/49/62	0.17 ± 0.04	0.07 ± 0.01	0.07 ± 0.02	0.13 ± 0.03	0.11 ± 0.02
Carbon Tetrachloride	50/50/50	NA	0.60 ± 0.02	0.64 ± 0.03	NA	NA	62/62/62	0.55 ± 0.06	0.68 ± 0.04	0.59 ± 0.07	0.56 ± 0.05	0.60 ± 0.03
1,2-Dichloroethane	47/41/50	NA	0.07 ± <0.01	0.04 ± 0.01	NA	NA	52/50/62	0.09 ± 0.01	0.09 ± 0.01	0.03 ± 0.02	0.06 ± 0.02	0.07 ± 0.01
Dichloromethane	50/50/50	NA	108.73 ± 167.61	90.69 ± 60.23	NA	NA	62/62/62	14.81 ± 18.74	0.68 ± 0.22	1.14 ± 0.65	0.65 ± 0.15	4.19 ± 4.52
Ethylbenzene	50/49/50	NA	0.29 ± 0.04	0.40 ± 0.08	NA	NA	62/62/62	0.33 ± 0.06	0.24 ± 0.05	0.30 ± 0.09	0.38 ± 0.09	0.30 ± 0.04
Formaldehyde	55/55/55	NA	3.12 ± 1.45	3.32 ± 0.36	2.99 ± 0.39	3.16 ± 0.51	59/59/59	2.85 ± 0.25	2.88 ± 0.49	3.11 ± 0.33	2.37 ± 0.28	2.80 ± 0.18
Acenaphthene[a]	55/55/55	6.06 ± 3.45	7.79 ± 3.03	17.80 ± 15.96	2.46 ± 0.89	8.29 ± 3.97	58/58/61	1.64 ± 0.60	6.29 ± 2.56	10.46 ± 2.25	4.56 ± 1.55	5.67 ± 1.20
Arsenic (PM_{10})[a]	57/57/57	0.35 ± 0.08	0.27 ± 0.06	0.22 ± 0.04	0.27 ± 0.06	0.28 ± 0.03	60/60/60	0.37 ± 0.12	0.24 ± 0.06	0.22 ± 0.05	0.44 ± 0.18	0.32 ± 0.06
Fluoranthene	55/55/55	2.11 ± 0.95	2.74 ± 0.82	15.75 ± 6.79	2.46 ± 0.51	5.59 ± 2.16	61/61/61	1.81 ± 0.29	6.79 ± 3.32	6.00 ± 2.17	2.07 ± 0.48	4.13 ± 1.09
Naphthalene[a]	55/55/55	98.50 ± 25.20	79.14 ± 17.27	95.14 ± 42.55	92.01 ± 20.60	91.01 ± 12.89	61/61/61	69.10 ± 15.96	55.13 ± 8.28	70.75 ± 16.45	102.89 ± 26.59	74.38 ± 9.54

NA = Not available because the criteria for calculating a quarterly and/or annual average were not met.
NS = Sampling was not conducted during this time.
[a] Average concentrations provided for the pollutants below the blue line for GPCO are presented in ng/m³ for ease of viewing.

Table 7-3. Quarterly and Annual Average Concentrations of the Pollutants of Interest for the Colorado Monitoring Sites (Continued)

Pollutant	2015						2016					
	# of Detects/ # >MDL/ # Samples	Q1 Avg (µg/m³)	Q2 Avg (µg/m³)	Q3 Avg (µg/m³)	Q4 Avg (µg/m³)	Annual Average (µg/m³)	# of Detects/ # >MDL/ # Samples	Q1 Avg (µg/m³)	Q2 Avg (µg/m³)	Q3 Avg (µg/m³)	Q4 Avg (µg/m³)	Annual Average (µg/m³)
Battlement Mesa, Colorado - BMCO												
Acetaldehyde	3/3/3	NA	NS	NS	NS	NA	24/24/24	NS	0.45 ± 0.25	0.62 ± 0.17	0.42 ± 0.12	0.48 ± 0.10
Benzene	6/6/6	NA	NS	NS	NS	NA	48/48/48	NS	0.70 ± 0.08	0.75 ± 0.08	0.97 ± 0.14	0.79 ± 0.06
Formaldehyde	3/3/3	NA	NS	NS	NS	NA	24/24/24	NS	0.78 ± 0.31	1.34 ± 0.27	0.78 ± 0.18	0.93 ± 0.18
Silt, Colorado - BRCO												
Acetaldehyde	28/28/28	0.32 ± 0.15	0.69 ± 0.34	0.58 ± 0.18	0.43 ± 0.19	0.51 ± 0.11	26/26/26	NA	0.39 ± 0.26	0.11 ± 0.06	0.16 ± 0.09	0.22 ± 0.08
Benzene	52/52/52	0.88 ± 0.36	0.55 ± 0.11	NA	0.66 ± 0.14	0.66 ± 0.12	57/57/58	1.09 ± 0.23	0.46 ± 0.11	0.60 ± 0.20	0.64 ± 0.21	0.71 ± 0.11
Formaldehyde	28/28/28	0.47 ± 0.25	1.08 ± 0.44	1.05 ± 0.31	0.67 ± 0.27	0.82 ± 0.17	26/26/26	NA	0.67 ± 0.41	0.16 ± 0.12	0.22 ± 0.15	0.37 ± 0.14
Glenwood Springs, Colorado - GSCO												
Acetaldehyde	26/26/26	NA	0.65 ± 0.26	0.48 ± 0.19	0.52 ± 0.18	0.53 ± 0.10	5/5/5	NA	NA	NS	NS	NA
Benzene	52/52/52	NA	0.42 ± 0.05	0.47 ± 0.07	0.59 ± 0.12	0.49 ± 0.04	12/12/12	0.83 ± 0.12	NA	NS	NS	NA
1,3-Butadiene	19/6/52	NA	0.01 ± 0.01	0	0.05 ± 0.02	0.02 ± 0.01	8/6/12	0.05 ± 0.03	NA	NS	NS	NA
Formaldehyde	26/26/26	NA	0.92 ± 0.34	0.93 ± 0.26	0.69 ± 0.18	0.80 ± 0.14	5/5/5	NA	NA	NS	NS	NA

NA = Not available because the criteria for calculating a quarterly and/or annual average were not met.
NS = Sampling was not conducted during this time.
[a] Average concentrations provided for the pollutants below the blue line for GPCO are presented in ng/m³ for ease of viewing.

Table 7-3. Quarterly and Annual Average Concentrations of the Pollutants of Interest for the Colorado Monitoring Sites (Continued)

Pollutant	2015						2016					
	# of Detects/ # >MDL/ # Samples	Q1 Avg (µg/m³)	Q2 Avg (µg/m³)	Q3 Avg (µg/m³)	Q4 Avg (µg/m³)	Annual Average (µg/m³)	# of Detects/ # >MDL/ # Samples	Q1 Avg (µg/m³)	Q2 Avg (µg/m³)	Q3 Avg (µg/m³)	Q4 Avg (µg/m³)	Annual Average (µg/m³)
Parachute, Colorado - PACO												
Acetaldehyde	17/17/18	NA	NA	0.57 ± 0.22	0.45 ± 0.28	NA	29/29/29	0.38 ± 0.30	0.61 ± 0.25	0.71 ± 0.12	0.64 ± 0.19	0.59 ± 0.11
Benzene	54/54/54	1.56 ± 0.35	0.92 ± 0.15	1.05 ± 0.15	NA	1.21 ± 0.16	54/54/54	1.18 ± 0.41	NA	1.22 ± 0.18	1.12 ± 0.23	1.20 ± 0.14
1,3-Butadiene	7/3/54	0.02 ± 0.02	<0.01 ± 0.01	0	NA	0.01 ± 0.01	2/0/54	<0.01 ± 0.01	NA	0	<0.01 ± 0.01	<0.01 ± <0.01
Formaldehyde	18/18/18	NA	NA	1.41 ± 0.32	0.97 ± 0.65	NA	29/29/29	0.66 ± 0.47	1.21 ± 0.37	1.59 ± 0.16	1.19 ± 0.25	1.18 ± 0.19
Carbondale, Colorado - RFCO												
Benzene	24/24/26	NA	0.46 ± 0.18	0.42 ± 0.05	0.42 ± 0.13	0.92 ± 0.68	27/27/27	0.59 ± 0.20	0.34 ± 0.07	0.43 ± 0.18	NA	0.45 ± 0.08
1,3-Butadiene	5/4/26	NA	0.02 ± 0.03	0	0.02 ± 0.03	0.01 ± 0.01	2/1/27	0.02 ± 0.02	0	0	NA	<0.01 ± 0.01
Carbon Tetrachloride	20/20/20	NA	0.60 ± 0.05	0.64 ± 0.06	NS	NA	NS	NS	NS	NS	NS	NS
1,2-Dichloroethane	19/14/20	NA	0.07 ± 0.01	0.04 ± 0.01	NS	NA	NS	NS	NS	NS	NS	NS
Rifle, Colorado - RICO												
Acetaldehyde	25/25/26	0.66 ± 0.24	NA	NA	1.01 ± 0.24	NA	30/30/30	0.90 ± 0.44	0.57 ± 0.15	0.90 ± 0.29	1.04 ± 0.24	0.86 ± 0.15
Benzene	44/44/46	1.25 ± 0.24	NA	NA	1.27 ± 0.22	NA	62/62/62	1.71 ± 0.32	0.71 ± 0.07	0.76 ± 0.05	1.13 ± 0.20	1.10 ± 0.14
1,3-Butadiene	38/32/46	0.10 ± 0.04	NA	NA	0.12 ± 0.02	NA	39/27/62	0.14 ± 0.04	0.02 ± 0.01	0.03 ± 0.03	0.10 ± 0.03	0.07 ± 0.02
Ethylbenzene	45/44/46	0.36 ± 0.10	NA	NA	0.34 ± 0.07	NA	62/62/62	0.36 ± 0.07	0.22 ± 0.04	0.27 ± 0.03	0.30 ± 0.05	0.29 ± 0.03
Formaldehyde	26/26/26	0.96 ± 0.33	1.17 ± 0.72	NA	1.44 ± 0.37	1.24 ± 0.21	30/30/30	1.20 ± 0.46	1.04 ± 0.22	1.52 ± 0.19	1.47 ± 0.31	1.31 ± 0.16

NA = Not available because the criteria for calculating a quarterly and/or annual average were not met.
NS = Sampling was not conducted during this time.
[a] Average concentrations provided for the pollutants below the blue line for GPCO are presented in ng/m³ for ease of viewing.

Observations for GPCO from Table 7-3 include the following:

- A number of VOC and carbonyl compound samples that did not run long enough were collected in February and March 2015; thus, these pollutants do not have first quarter average concentrations provided. This combined with additional invalid samples throughout the year, particularly during the fourth quarter, results in a completeness less than 85 percent for the VOCs and thus, fourth quarter and annual averages could not be calculated either. However, statistical summaries for 2015 are provided in Appendix J for the valid samples collected.

- Excluding the VOCs, formaldehyde is the pollutant with the highest annual average concentration for GPCO in 2015 (3.16 ± 0.51 µg/m^3). While the available 2015 quarterly average concentrations do not vary significantly, the confidence interval for the second quarter is three to four times greater than the other confidence intervals shown. A review of the data shows that the maximum formaldehyde concentration (15.1 µg/m^3) was measured at GPCO on May 3, 2015; the next highest formaldehyde (5.12 µg/m^3) is one-third as high. GPCO is one of only six NMP sites at which a formaldehyde concentration greater than 15 µg/m^3 was measured during 2015 and 2016. Formaldehyde concentrations measured at GPCO over the two years of sampling range from 1.01 µg/m^3 to 15.1 µg/m^3. Based on the averages shown in Table 7-3, formaldehyde concentrations appear higher in 2015 than in 2016, though the difference is not statistically significant. All but one of the 10 formaldehyde concentrations greater than 4 µg/m^3 were measured at GPCO in 2015.

- The maximum acetaldehyde concentration was also measured at GPCO on May 3, 2015 (3.95 µg/m^3), although the difference between this measurement and other "higher" concentrations measured at this site are considerably less. Acetaldehyde concentrations measured at GPCO range from 0.645 µg/m^3 to 3.95 µg/m^3, with a total of six concentrations greater than or equal to 3 µg/m^3 measured over the two-year period.

- The available quarterly average concentrations of dichloromethane exhibit considerable variability, spanning three orders of magnitude. The second and third quarter average concentrations for 2015 are both around 100 µg/m^3, with very large confidence intervals associated with them. Prior to the April 2016, dichloromethane concentrations measured at GPCO range from 0.397 µg/m^3 to 1,493 µg/m^3, including seven concentrations greater than 100 µg/m^3 and 22 greater than 10 µg/m^3. After the first quarter of 2016, both the magnitude and variability of the measurements decrease significantly; concentrations greater than 5 µg/m^3 were not measured at GPCO after the first quarter of 2016, with only eight concentrations greater than 1 µg/m^3 measured during this nine-month period.

- Concentrations of benzene and 1,3-butadiene appear highest during the colder months of the year, based on the quarterly average concentrations for 2016 shown in Table 7-3. A review of the data shows that all but one of the 11 benzene concentrations greater than 1 µg/m^3 were measured during the first or fourth quarters of 2016 (and the one exception was in mid-September). Conversely, all but three of the 21 benzene concentrations less than 0.5 µg/m^3 were measured between April and September, during the second or third quarters of 2016. While similar trends are also

shown in the 2015 data, the maximum benzene concentration was measured in July (3.39 µg/m^3), explaining the relatively large confidence interval for the third quarter of 2015. Similarly, the 15 highest 1,3-butadiene concentrations were measured at GPCO during the first or fourth quarters of 2016 while most of the lowest concentrations were measured between April and September. Similar observations were made in the 2014 NMP report.

- All four quarterly average concentrations for both years are provided in Table 7-3 for the PAH and metal pollutants of interest. Concentrations of arsenic measured across the two years of sampling do not exhibit much variability; arsenic concentrations measured at GPCO range from 0.070 ng/m^3 to 1.40 ng/m^3, with the bulk of the measurements falling between 0.10 ng/m^3 and 0.60 ng/m^3. The four highest arsenic concentrations (those greater than 0.7 ng/m^3) were measured at GPCO during the first and fourth quarters of 2016, contributing to the larger confidence intervals shown for these quarterly average concentrations.

- Among the PAHs, naphthalene has the highest annual average concentrations for both years. Concentrations of naphthalene measured at GPCO range from 18.0 ng/m^3 to 321 ng/m^3; the maximum naphthalene concentration measured at GPCO is the fourth highest among NMP sites sampling this pollutant. The second quarter average concentrations of naphthalene for both years, but particularly for 2016, appear lower than the other quarterly averages shown. The maximum concentration measured during the second quarter of 2016 is 87.3 ng/m^3; multiple concentrations greater than 87.3 ng/m^3 were measured during every other calendar quarter, from as few as four (first quarter 2016) to as many as 11 (fourth quarter 2016).

- The third quarter average concentration of acenaphthene for 2015 is considerably higher than the other quarterly average concentrations shown for both years, and its associated confidence interval is nearly the same magnitude as the average itself (17.80 ± 15.96 ng/m^3). A review of the data shows that the maximum acenaphthene concentration (108 ng/m^3) was measured at GPCO on July 17, 2015; the next highest concentration (25.5 ng/m^3) was also measured in July 2015, but is one-quarter the magnitude. GPCO's maximum acenaphthene concentration is the highest concentration of this pollutant measured among NMP sites sampling this pollutant. The highest concentrations of acenaphthene measured at GPCO tended to be measured during the warmer months of the year. Of the 18 acenaphthene concentrations greater than 10 ng/m^3 measured at GPCO, 16 were measured between June and September.

- The highest concentrations of fluoranthene were also measured at GPCO during the third quarter of 2015, including all four measurements greater than 25 ng/m^3. There is little variation in the quarterly averages for 2015, with the exception of the third quarter. For 2016, the second and third quarter averages are significantly higher than the first and fourth quarter averages. Similar to acenaphthene, the highest fluoranthene concentrations tended to be measured during the warmer months of the year. The 17 highest fluoranthene concentrations were measured at GPCO between June and September of either year. Few fluoranthene concentrations greater than 5 ng/m^3 were measured outside these months (one of 12 in 2015 and two in 2016, out of a total of 25).

Observations for the Garfield County sites from Table 7-3 include the following:

- Several quarterly average concentrations, and some annual averages are "missing" for the Garfield County sites in Table 7-3. The reasons for this are varied, including:
  - The instrumentation at BMCO was moved to GSCO in February 2015, then was returned to the BMCO location in March 2016.
  - Due to the instrument relocation from GSCO back to BMCO in March 2016 and one invalid sample, the criteria for a quarterly average concentration to be calculated was not met.
  - A quarterly average concentration for the third quarter of 2015 could not be calculated for BRCO due to flow controller issues with the SNMOC collection system in September and October 2015. Quarterly averages for the carbonyl compounds for the first quarter of 2016 could not be calculated for BRCO due to collection system issues experienced in January and February.
  - A series of carbonyl compound samples resembling field blanks was collected at PACO during the first half of 2015, resulting in the invalidation of one-third of the samples collected in 2015.
  - Canisters were analyzed for both VOCs and SNMOCs concurrently at RFCO between January and September 2015; thus, VOC pollutants of interest for 2015 not on the SNMOC analyte list would not have any averages for 2016. Also, a number of invalid samples were collected in the first half of 2015 resulting in no quarterly averages for the first quarter of 2015.
  - A number of SNMOC samples did not run properly at RICO in June and first part of July 2015; this combined with other invalid samples throughout the year resulted in a completeness less than 85 percent for RICO in 2015.
  - RICO has a quarterly average concentration for formaldehyde for the second quarter of 2015 while acetaldehyde does not. This is due to co-elution for one sample, for which an acetaldehyde concentration could not be resolved.
- Acetaldehyde and formaldehyde are pollutants of interest for each Garfield County site that sampled carbonyl compounds (all sites except RFCO).
- Quarterly average concentrations of acetaldehyde range from 0.11 ± 0.06 µg/m^3 (BRCO, third quarter 2016) to 1.04 ± 0.37 µg/m^3 (RICO, fourth quarter 2016). BRCO has four of the five lowest quarterly average concentrations among the Garfield County sites as well as NMP sites. In fact, the Garfield County sites account for 10 of the 11 quarterly averages of acetaldehyde less than 0.5 µg/m^3. RICO is the only site for which a quarterly average concentration of acetaldehyde greater than 1 µg/m^3 was calculated. BRCO and RICO also have the lowest (0.22 ± 0.08 µg/m^3 - BRCO, 2016) and highest (0.86 ± 0.15 µg/m^3 - RICO, 2016) annual average concentrations, respectively, of acetaldehyde among the Garfield County sites. Excluding RICO, Garfield County sites account for the five lowest annual average concentrations of acetaldehyde among sites sampling this pollutant. BRCO is the only Garfield County site for which an annual average concentration could be calculated for both years. BRCO's annual average concentration for 2015 (0.51 ± 0.11 µg/m^3) is more than twice the annual average concentration for 2016 (0.22 ± 0.08 µg/m^3).

- Quarterly average concentrations of formaldehyde range from 0.16 ± 0.06 µg/m^3 (BRCO, third quarter 2016) to 1.59 ± 0.37 µg/m^3 (PACO, third quarter 2016). BRCO has the two lowest quarterly average concentrations of formaldehyde among NMP sites. The Garfield County sites account for 13 of the 21 quarterly averages of formaldehyde less than 1 µg/m^3 (SEWA accounts for the others). RICO has the most quarterly average concentrations of formaldehyde greater than 1 µg/m^3 (six) among the Garfield County sites. BRCO and RICO also have the lowest (0.37 ± 0.14 µg/m^3 - BRCO, 2016) and highest (1.31 ± 0.16 µg/m^3 - RICO, 2016) annual average concentrations, respectively, of formaldehyde among the Garfield County sites. BRCO's 2016 annual average concentration of formaldehyde is the lowest annual average concentration of formaldehyde among sites sampling this pollutant. BRCO and RICO are the only Garfield County sites for which an annual average formaldehyde concentration could be calculated for both years. BRCO's annual average concentration for 2015 (0.82 ± 0.17 µg/m^3) is also more than twice the annual average concentration for 2016 (0.37 ± 0.14 µg/m^3), while RICO's annual averages are similar to each other.

- Benzene was sampled for and is a pollutant of interest for all six Garfield County sites. Quarterly average concentrations of benzene range from 0.34 ± 0.07 µg/m^3 (RFCO, second quarter 2016) to 1.71 ± 0.37 µg/m^3 (RICO, first quarter 2016). This quarterly average concentration for RICO is among the highest quarterly averages of benzene among NMP sites sampling this pollutant, while the quarterly average for RFCO is among the lowest. PACO (5) and RICO (4) have the most quarterly average concentrations of benzene greater than 1 µg/m^3. RFCO has the lowest annual average concentration of benzene (0.45 ± 0.08 µg/m^3 - 2016) while PACO has the highest (1.21 ± 0.16 µg/m^3 - 2015) among the Garfield County sites. Both of PACO's annual average concentrations of benzene are among the highest annual averages for this pollutant. BRCO, PACO, and RFCO are the Garfield County sites for which an annual average benzene concentration could be calculated for both years. There is little difference between the annual averages for BRCO and PACO, while the annual average for 2015 for RFCO (0.92 ± 0.68 µg/m^3) is twice the annual average concentration for 2016 (0.45 ± 0.08 µg/m^3). Note that the confidence interval for the RFCO's 2015 annual average is considerably large, indicating the potential for outliers. The confidence intervals shown for the available 2015 quarterly average concentrations do not reflect this level of variability. A review of the data shows that the four highest benzene concentrations measured at RFCO were measured in February and March and range from 0.902 µg/m^3 to 6.62 µg/m^3; the two highest benzene concentrations measured at RFCO are the second and third highest concentrations of benzene measured across the program. Note that for pollutants on both the VOC and SNMOC analyte list, such as benzene, the measurements provided by the SNMOC method were used for RFCO.

- 1,3-Butadiene is also a pollutant of interest for GSCO, PACO, RFCO, and RICO. This pollutant is detected at these sites at a lower rate than the other pollutants of interest shown in Table 7-3. In fact, several of the quarterly average concentrations are zero, indicating that 1,3-butadiene was not detected during that calendar quarter. RICO is the only Garfield County site with a quarterly average concentration of 1,3-butadiene greater than 0.1 µg/m^3. Annual average concentrations of 1,3-butadiene

range from <0.01 ± <0.01 µg/m^3 (PACO, 2016) to 0.07 ± 0.02 µg/m^3 (RICO, 2016) among the Garfield County sites.

- Carbon tetrachloride and 1,2-dichloroethane were also identified as pollutants of interest for RFCO. These pollutants are analytes on the VOC list only; thus, few quarterly average concentrations are shown in Table 7-3.

- Ethylbenzene is also a pollutant of interest for RICO. The quarterly average concentrations of ethylbenzene do not vary significantly among the available quarterly averages shown in Table 7-3.

Tables 4-10 through 4-13 present the NMP sites with the 10 highest annual average concentrations for each of the program-level pollutants of interest. Observations for the Colorado sites from those tables include the following:

- Annual average concentrations for the Colorado sites appear in Tables 4-10 through 4-13 a total of seven times, with GPCO appearing the most (4).

- PACO has the second (2015) and third (2016) highest annual average concentrations of benzene among all NMP sites sampling this pollutant, as indicated above, with RICO's 2016 annual average ranking sixth highest.

- None of the Colorado sites appear in Table 4-11 for the carbonyl compounds.

- GPCO has the fifth highest annual concentration of naphthalene (2015) among NMP sites sampling PAHs, as shown in Table 4-12. This site's annual average naphthalene concentration for 2016 ranks 11th highest. GPCO's annual averages of acenaphthene rank 7th (2015) and 10th (2016) highest among sites sampling these pollutants. GPCO's 2015 annual average of fluorene also ranks 7th highest among sites sampling these pollutants, with this site's 2016 annual average ranking 12th.

- GPCO does not appear in Table 4-13 for arsenic.

7.3.2 Concentration Comparison

In order to better illustrate how each site's annual average concentrations compare to the program-level averages, a site-specific box plot was created for each of the site-specific pollutants of interest, where applicable. Thus, box plots were created for each of the pollutants listed in Table 7-3 for each site. Note that the box plots for benzene, 1,3-butadiene, and ethylbenzene were split into separate figures, one for samples collected and analyzed with Method TO-15 (GPCO, RFCO) and one for samples collected and analyzed with the SNMOC method (the Garfield County sites), where annual averages could be calculated. Figures 7-11 through 7-22 overlay the sites' minimum, annual average, and maximum concentrations for each year onto the program-level minimum, first quartile, median, average, third quartile, and maximum concentrations, as described in Section 3.4.2.1, and are discussed below. If an annual

average concentration could not be calculated, the range of concentrations is still provided in the figures that follow.

Figure 7-11. Program vs. Site-Specific Average Acenaphthene Concentrations

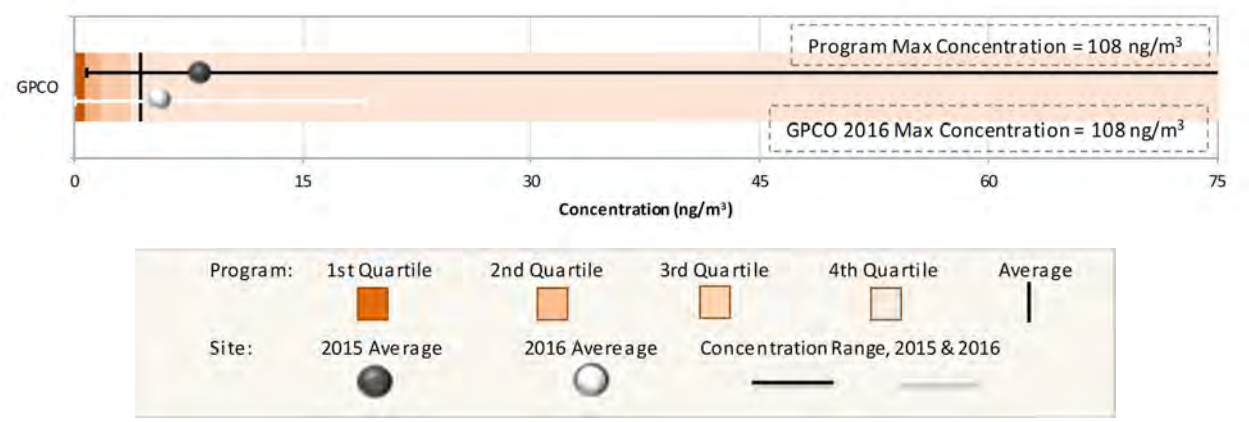


Figure 7-11 presents the box plot for acenaphthene for GPCO and shows the following:

- The program-level maximum acenaphthene concentration (108 ng/m^3) is not shown directly on the box plot in Figure 7-11 because the scale of the box plot would be too large to readily observe data points at the lower end of the concentration range. Thus, the scale has been reduced.

- The maximum acenaphthene concentration measured at GPCO in 2015 is the maximum acenaphthene concentration measured across the program, as discussed in the previous section. Although the range of concentrations measured at GPCO in 2015 appears considerably larger than the range measured in 2016, if the maximum concentration is excluded, the ranges are more similar (the second highest concentration measured in 2015 is 25.5 ng/m^3).

- The minimum concentration measured in 2015 is greater than the program-level 25th percentile. There were three non-detects measured in 2016 (compared to none in 2015).

- Both annual average concentrations of acenaphthene for GPCO are greater than the program-level average concentration as well as the program-level third quartile. As discussed in the previous section, GPCO's annual averages are among the highest calculated for this pollutant.

Figure 7-12. Program vs. Site-Specific Average Acetaldehyde Concentrations

Figure 7-12 presents the box plots for acetaldehyde and shows the following:

- The box plots show that the range of acetaldehyde concentrations measured at GPCO is considerably larger than the range of concentrations measured at the Garfield County sites. The entire range of acetaldehyde concentrations measured at most of the Garfield County sites (RICO being the exception) is less than the program-level average concentration. However, the range of concentrations measured at all of the Colorado sites is relatively small compared to the range measured across the program.

Note that the range of measurements for BMCO in 2015 is very small but represents only one month of sampling.

- GPCO has the highest annual average acetaldehyde concentrations among the Colorado sites, where they could be calculated. The 2015 annual average concentration for GPCO is similar to the program-level average concentration and the 2016 annual average is just greater than the program average. By comparison, the annual average concentrations for most of the Garfield County sites are less than the program-level first quartile.

- Carbonyl compounds were not sampled for at RFCO.

Figure 7-13. Program vs. Site-Specific Average Arsenic (PM_{10}) Concentrations

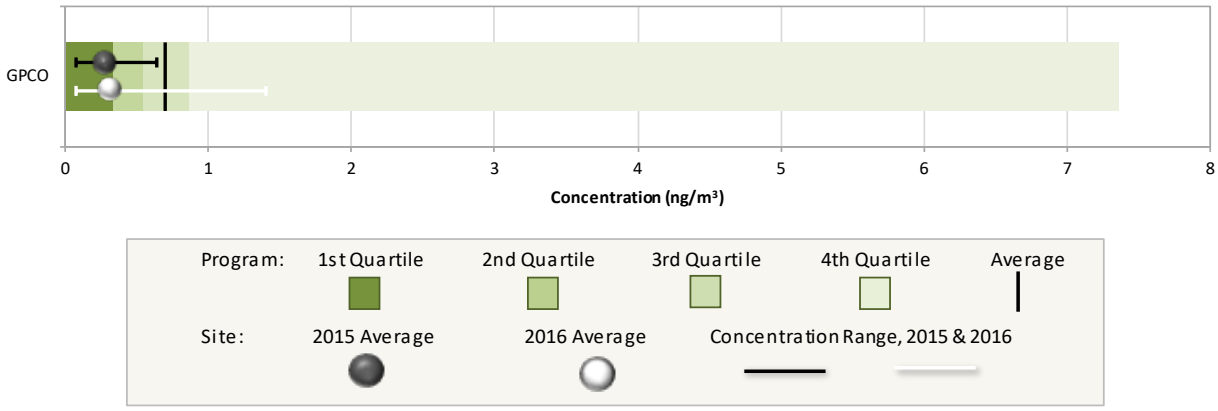


Figure 7-13 presents the box plot for arsenic for GPCO and shows the following:

- The maximum arsenic concentration measured at GPCO in 2016 is more than twice the maximum arsenic concentration measured in 2015. The entire range of concentrations measured in 2015 is less than the program-level average concentration (0.703 ng/m^3). For 2016, only the maximum concentration measured is greater than the program-level third quartile; all but the three highest concentrations measured at GPCO in 2016 are less than the program-level average concentration.

- The 2015 and 2016 annual average concentrations for GPCO are similar to each other and both are just less than the program-level first quartile. This site has the lowest annual average concentrations of arsenic among NMP sites sampling arsenic.

Figure 7-14a. Program vs. Site-Specific Average Benzene (Method TO-15) Concentrations

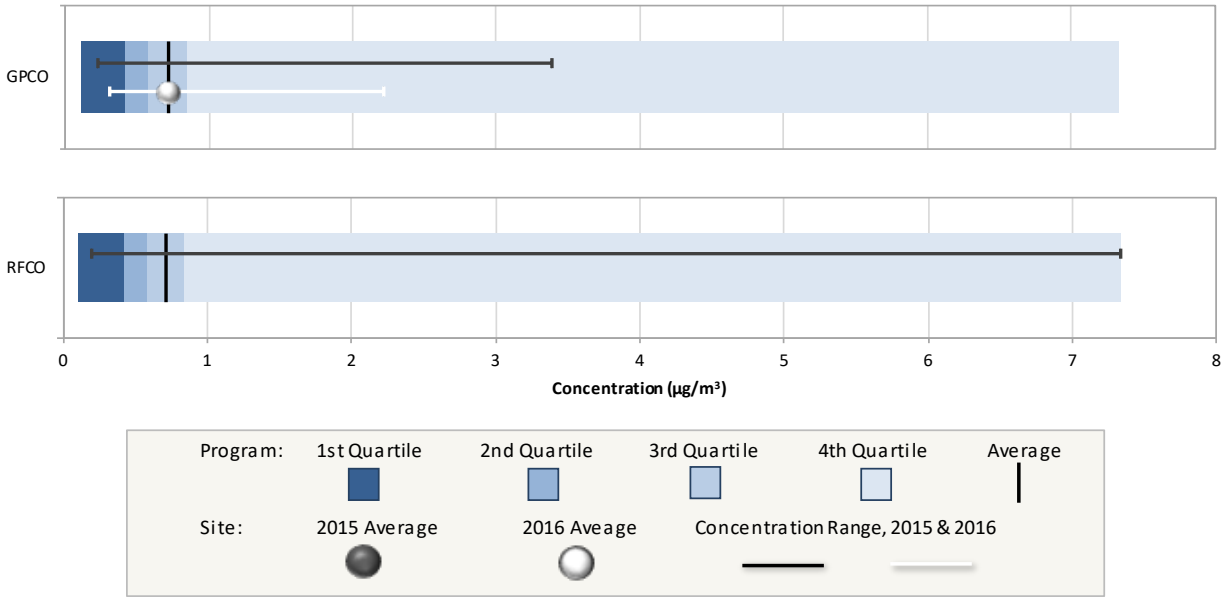


Figure 7-14a presents the box plots for benzene (TO-15) and shows the following:

- Figure 7-14a presents the minimum, maximum, and annual average concentrations of benzene, where available, for GPCO and RFCO compared to the benzene concentrations measured across the program for NMP sites sampling VOCs with Method TO-15. As previously discussed, canisters collected at RFCO were analyzed with Method TO-15 between January and September 2015.

- The two highest benzene concentrations measured across the program were measured at RFCO (7.33 µg/m^3 and 7.30 µg/m^3). The next highest benzene concentration measured at RFCO is also among the highest across the program (4.42 µg/m^3). These three concentrations were measured at RFCO on three consecutive sample days in March 2015; the remaining measurements are less than 1 µg/m^3, ranging from 0.198 µg/m^3 to 0.567 µg/m^3.

- Although the maximum benzene concentration measured at GPCO is roughly half the magnitude as the maximum concentration measured at RFCO, it is still among the higher benzene concentrations measured across the program. The range of benzene concentrations measured at GPCO in 2015 is larger than the range measured in 2016.

- The annual average concentration for GPCO for 2016 is similar to the program-level average concentration. (An annual average could not be calculated for 2015.)

Figure 7-14b. Program vs. Site-Specific Average Benzene (SNMOC) Concentrations

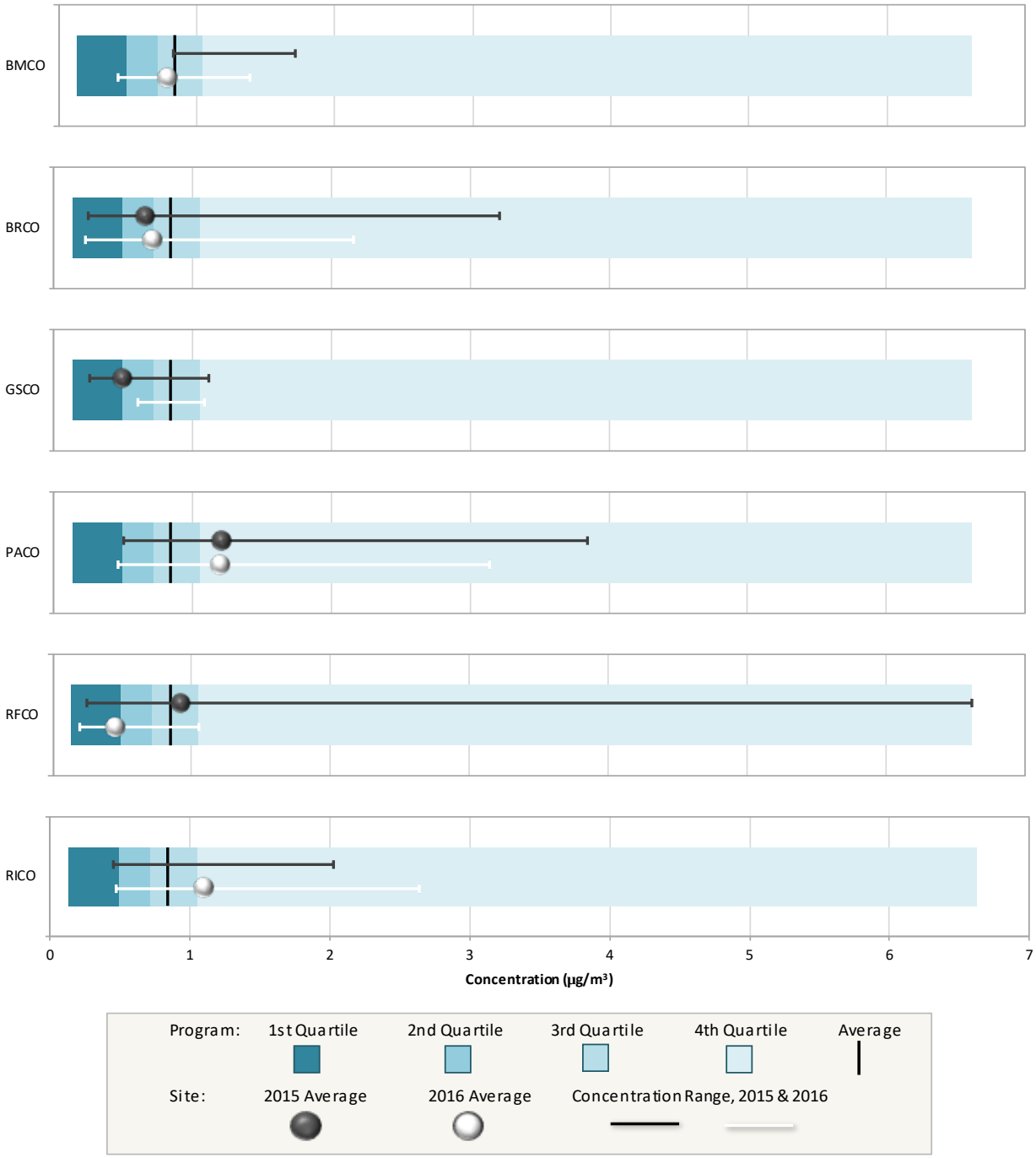


Figure 7-14b presents the box plots for benzene (SNMOC) and shows the following:

- Figure 7-14b presents the minimum, maximum, and annual average benzene concentrations for the Garfield County sites compared to the benzene concentrations measured across the program for NMP sites sampling SNMOCs. Note that the scales vary slightly between Figures 7-14a and 7-14b.

- The higher benzene concentrations measured at RFCO with Method TO-15 are reflected in the benzene concentrations measured with the concurrent SNMOC

method. The range of benzene concentrations measured across the Garfield County sites is highly variable.

- Of the Garfield County sites, PACO has the highest annual average concentrations of benzene, followed by RICO (2016) and RFCO (2015). The available annual average concentrations for the remaining sites (and RFCO's 2016 annual average) are less than the program-level average concentration, with several also less than the program-level median concentration.

- For the sites with two available annual averages, the difference between the two is largest for RFCO.

Figure 7-15a. Program vs. Site-Specific Average 1,3-Butadiene (Method TO-15) Concentrations

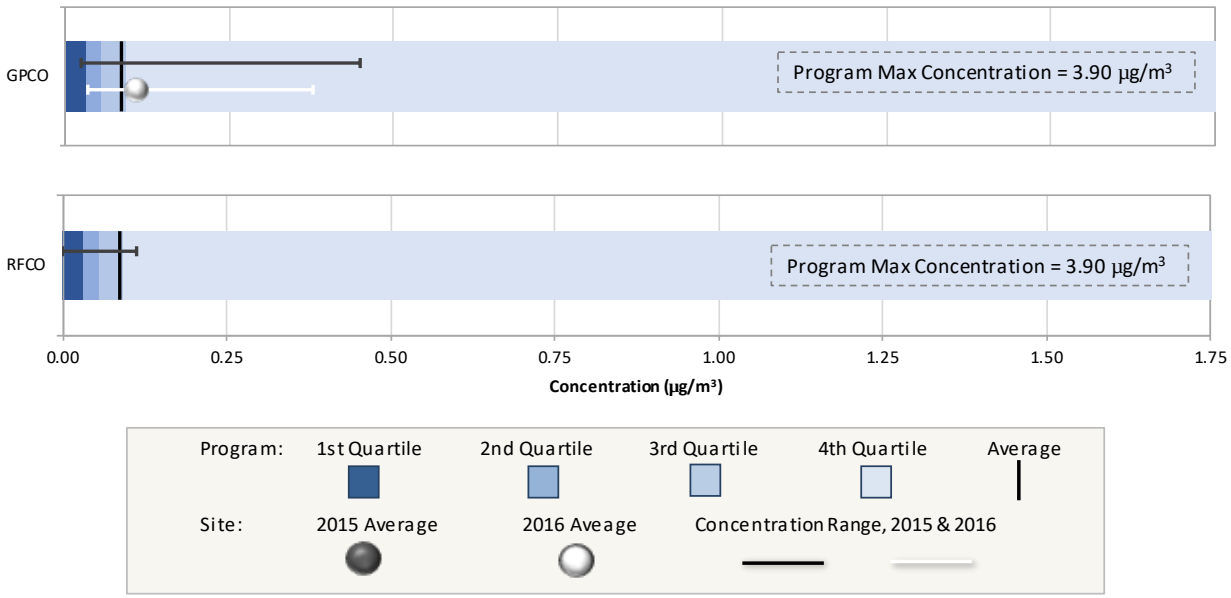


Figure 7-15a presents the box plots for 1,3-butadiene (TO-15) and shows the following:

- Figure 7-15a presents the minimum, maximum, and annual average concentrations of 1,3-butadiene, where available, for GPCO and RFCO compared to the 1,3-butadiene concentrations measured across the program for NMP sites sampling VOCs with Method TO-15. As previously discussed, canisters collected at RFCO were analyzed with Method TO-15 between January and September 2015.

- The program-level maximum 1,3-butadiene concentration (3.90 µg/m^3) is not shown directly on the box plots in Figure 7-15a because the scale of the box plots has been reduced to allow for the observation of data points at the lower end of the concentration range.

- Figure 7-15a shows that the maximum 1,3-butadiene concentration measured at GPCO is an order of magnitude less than the program-level maximum concentration. The range of 1,3-butadiene concentrations measured at GPCO in 2016 is just slightly less than the range measured in 2015. For RFCO, all but one 1,3-butadiene

concentration are less than 0.1 µg/m^3. Non-detects of 1,3-butaidene were not measured at GPCO, as the minimum 1,3-butadiene concentration for both years are similar to the program-level first quartile. Two non-detects were measured at RFCO.

- GPCO's annual average concentration of 1,3-butadiene for 2016 is greater than both the program-level average concentration and the program-level third quartile.

Figure 7-15b. Program vs. Site-Specific Average 1,3-Butadiene (SNMOC) Concentrations

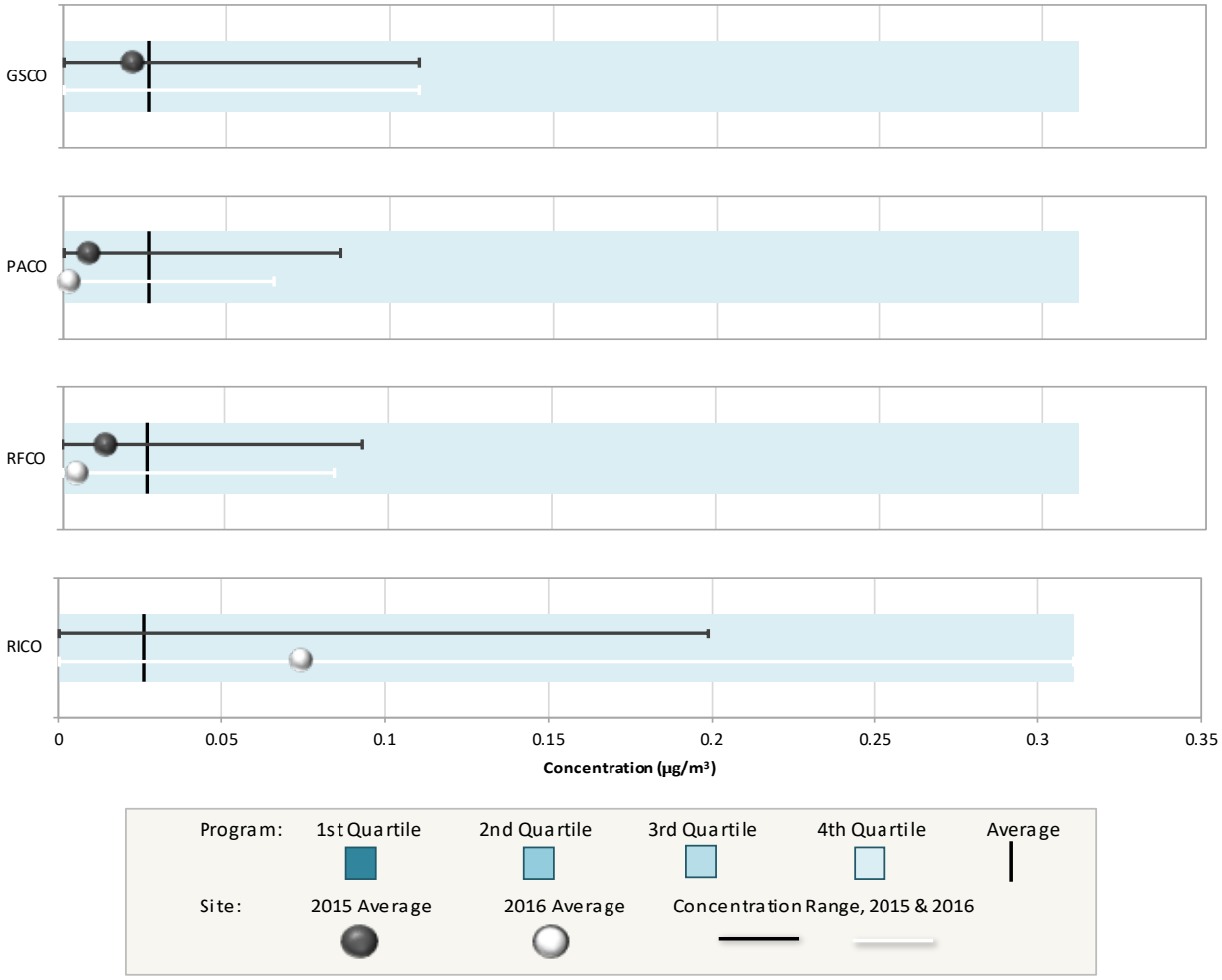


Figure 7-15b presents the box plots for 1,3-butadiene (SNMOC) and shows the following:

- Figure 7-15b includes a box plot for GSCO, PACO, RFCO, and RICO, the Garfield County sites for which 1,3-butadiene is a pollutant of interest. The program-level first, second, and third quartiles are zero for sites sampling SNMOCs, and thus, not visible in Figure 7-15b, indicating that at least 75 percent of the 1,3-butadiene concentrations measured by sites sampling SNMOCs were non-detects. The box plots show that non-detects were measured at each of the Garfield County sites shown.

- The maximum 1,3-butadiene concentration measured at RICO (0.311 µg/m^3) is roughly three to five times the maximum concentrations measured among the remaining Garfield County sites.

- Of the Garfield County sites shown, RICO has the highest annual average concentration of 1,3-butadiene (2016) and is the only one greater than the program-level average 1,3-butadiene concentration.

Figure 7-16. Program vs. Site-Specific Average Carbon Tetrachloride Concentrations

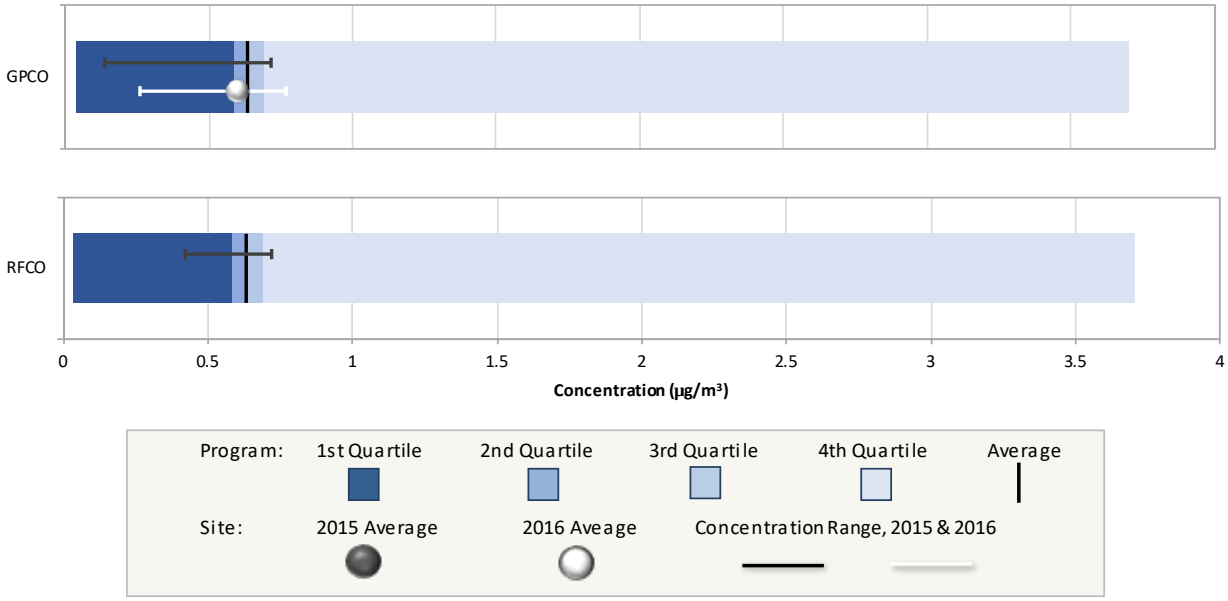


Figure 7-16 presents the box plots for carbon tetrachloride for GPCO and RFCO and shows the following:

- The range of carbon tetrachloride concentrations measured at these two sites is considerably smaller than the range measured across the program, particularly for RFCO.

- The program-level median and average concentrations are nearly identical and thus, plotted nearly on top of each other in Figure 7-16.

- The annual average carbon tetrachloride concentration for GPCO for 2016 is greater than the program-level first quartile but less than the program-level median and average concentrations. GPCO's 2016 annual average of carbon tetrachloride is among the lowest annual averages among NMP sites sampling this pollutant. However, the variability in annual averages of carbon tetrachloride among NMP sites is rather small, with 0.1 µg/m^3 separating most sites' annual averages.

Figure 7-17. Program vs. Site-Specific Average 1,2-Dichloroethane Concentrations

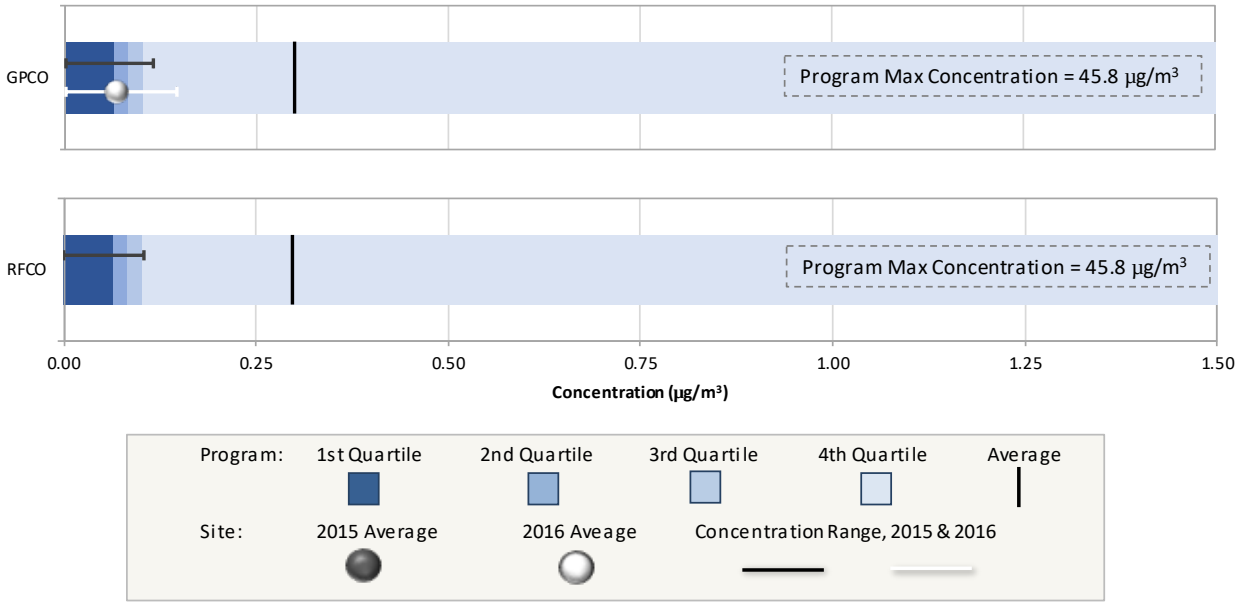


Figure 7-17 presents the box plots for 1,2-dichloroethane for GPCO and RFCO and shows the following:

- The program-level maximum 1,2-dichloroethane concentration (45.8 µg/m^3) is not shown directly on the box plots in Figure 7-17 as the program-level maximum concentration is considerably greater than the majority of concentrations measured across the program.

- All of the concentrations of 1,2-dichloroethane measured at GPCO and RFCO are less than the program-level average concentration of 0.30 µg/m^3. The maximum concentration of 1,2-dichloroethane measured at GPCO (0.146 µg/m^3) is half the magnitude of the program-level average concentration and RFCO's maximum concentration (0.105 µg/m^3) is one-third the magnitude.

- The annual average concentration for GPCO for 2016 falls between program-level first quartile and median concentration. The program-level average concentration is being driven by the measurements at the upper end of the concentration range.

Figure 7-18. Program vs. Site-Specific Average Dichloromethane Concentrations

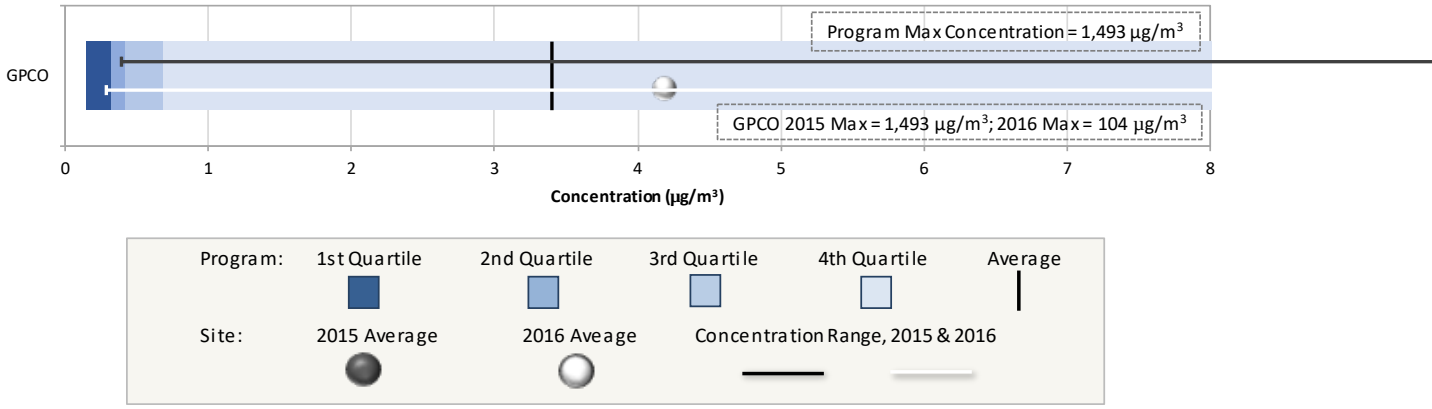


Figure 7-18 presents the box plot for dichloromethane for GPCO and shows the following:

- The program-level maximum dichloromethane concentration (1,493 µg/m^3) is not shown directly on the box plot in Figure 7-18 as the program-level maximum concentration is considerably greater than the majority of concentrations measured across the program.

- The program-level average concentration of dichloromethane is also being driven by the measurements at the upper end of the concentration range. While the maximum dichloromethane concentration measured at GPCO in 2015 is the maximum concentration measured across the program, GPCO is not the only site at which a dichloromethane concentration greater than 1000 µg/m^3 was measured. The maximum dichloromethane concentration measured at GPCO in 2016 is an order of magnitude less than the maximum concentration measured in 2015, though both of these measurements exceed the scale in Figure 7-18.

Figure 7-19a. Program vs. Site-Specific Average Ethylbenzene (Method TO-15) Concentrations

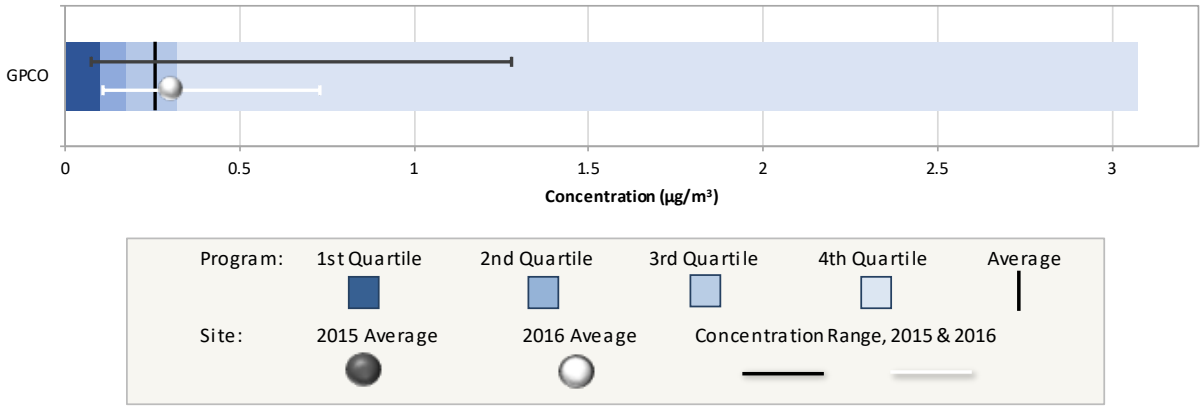


Figure 7-19a presents the box plot for ethylbenzene (TO-15) for GPCO and shows the following:

- Figure 7-19a presents the minimum, maximum, and annual average concentrations of ethylbenzene, where available, for GPCO compared to the ethylbenzene concentrations measured across the program for NMP sites sampling VOCs with Method TO-15. A box plot is not provided for RFCO because ethylbenzene is not a pollutant of interest for this site.

- Six concentrations measured at GPCO in 2015 are greater than the maximum concentration measured in 2016, as the maximum ethylbenzene concentration measured at GPCO in 2015 is nearly twice the magnitude of the maximum concentration measured in 2016.

- Although a few non-detects of ethylbenzene were measured across the program, none were measured at GPCO.

- GPCO's annual average concentration of ethylbenzene for 2016 falls between the program-level average concentration and third quartile.

Figure 7-19b. Program vs. Site-Specific Average Ethylbenzene (SNMOC) Concentrations

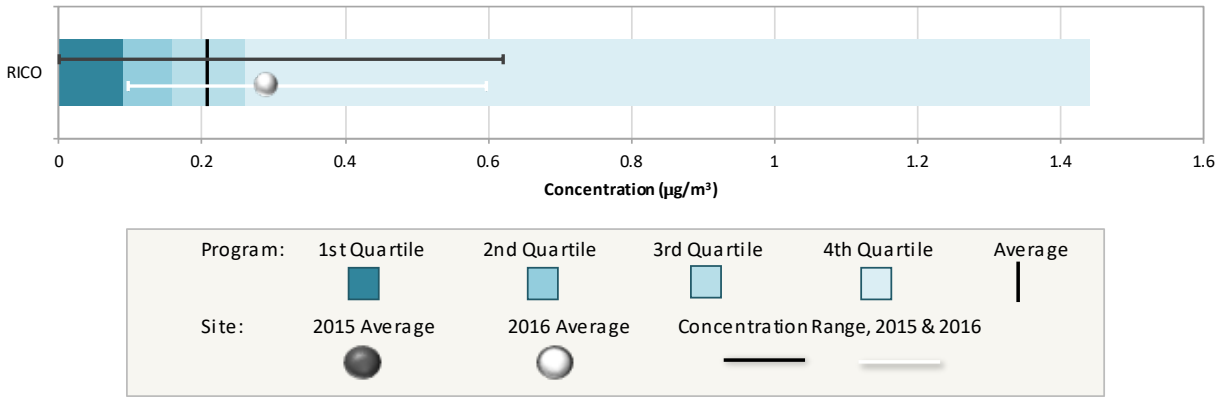


Figure 7-19b present the box plot for ethylbenzene (SNMOC) for RICO and shows the following:

- Figure 7-19b includes a box plot for RICO, the only Garfield County site for which ethylbenzene is a pollutant of interest.

- Although maximum concentrations measured at RICO each year are fairly similar, the minimum concentrations are considerably different. A single non-detect was measured at RICO in 2015; if this non-detect was excluded from the dataset, the minimum concentrations for each year would be more similar.

- RICO's annual average concentration of ethylbenzene for 2016 is greater than the program-level average concentration and third quartile for ethylbenzene concentrations measured at sites sampling SNMOCs.

Figure 7-20. Program vs. Site-Specific Average Fluoranthene Concentrations

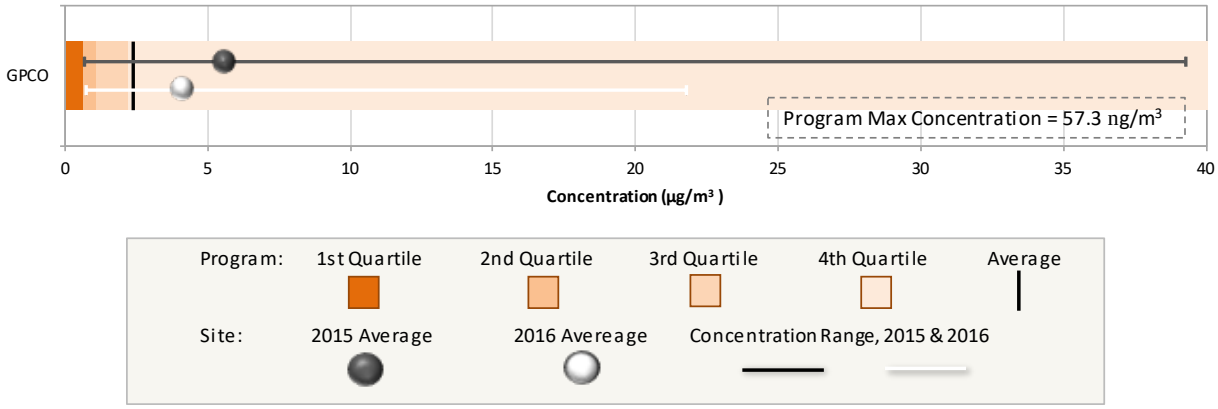


Figure 7-20 presents the box plot for fluoranthene for GPCO and shows the following:

- The program-level maximum fluoranthene concentration (57.3 ng/m^3) is not shown directly on the box plot in Figure 7-20 because the scale of the box plot would be too large to readily observe data points at the lower end of the concentration range; thus, the scale has been reduced.

- GPCO is one of only two NMP sites sampling PAHs where a fluoranthene concentration greater than 25 ng/m^3 was measured, though concentrations measured at GPCO account for only four of the 17 fluoranthene measurements of this magnitude.

- Both annual average concentrations of fluoranthene for GPCO are greater than the program-level average concentration and third quartile. GPCO's 2015 annual average concentration ranks fourth highest among sites sampling this pollutant. Because fluoranthene is not a program-level pollutant of interest, this pollutant is not shown in annual average comparison table (Table 4-12).

Figure 7-21. Program vs. Site-Specific Average Formaldehyde Concentrations

Figure 7-21 presents the box plots for formaldehyde and shows the following:

- The box plots show that the range of formaldehyde concentrations measured at GPCO is considerably larger than the range of concentrations measured at the Garfield County sites, particularly for 2015. The entire range of formaldehyde concentrations measured at the Garfield County sites is less than the program-level average concentration (and in many cases, also less than the program-level median concentration). Note that the range of measurements for BMCO in 2015 is very small but represents only one month of sampling.

- GPCO has the highest annual average formaldehyde concentrations among the Colorado sites, where they could be calculated. The annual averages for GPCO fall on either side of the program-level average concentration. By comparison, the available annual average concentrations for the Garfield County sites are all less than the program-level first quartile.

- Carbonyl compounds were not sampled for at RFCO.

Figure 7-22. Program vs. Site-Specific Average Naphthalene Concentrations

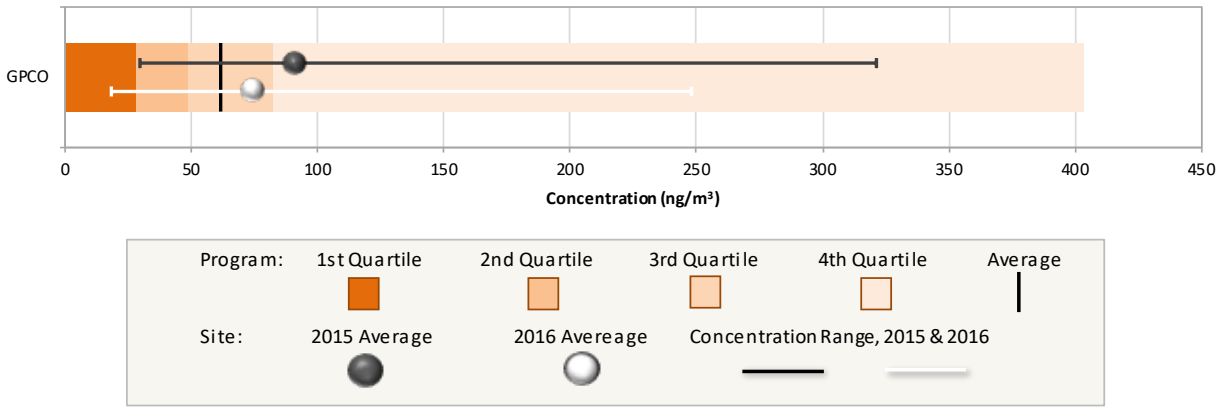


Figure 7-22 presents the box plot for naphthalene for GPCO and shows the following:

- Although the maximum naphthalene concentration measured at GPCO is not the maximum concentration measured across the program, it is among one of the highest measured.

- The minimum concentration of naphthalene measured at GPCO in 2015 is greater than the program-level first quartile, indicating that this measurement is higher than 25 percent of the naphthalene concentrations measured over the two years of sampling.

- GPCO's 2015 annual average naphthalene concentration is greater than the program-level average concentration and third quartile, while GPCO's 2016 annual average naphthalene concentration falls between the two. As previously discussed, GPCO's annual average concentration for 2015 is the fifth highest annual average naphthalene concentration among NMP sites sampling PAHs.

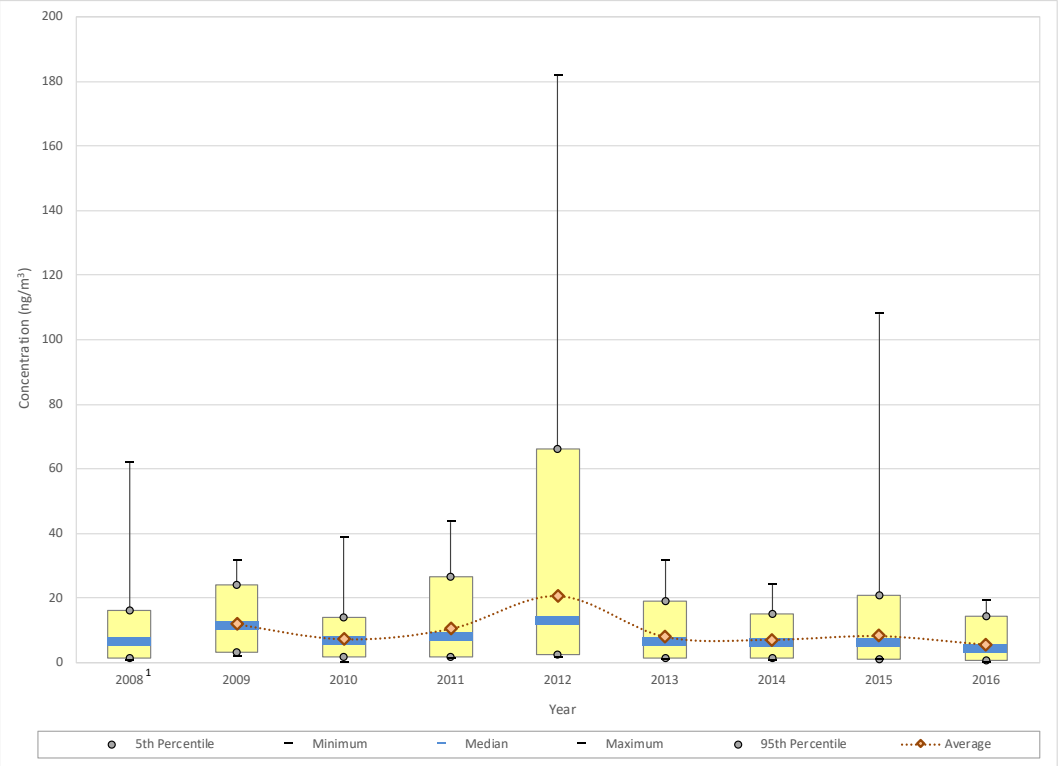
7.3.3 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the pollutants of interest for 5 consecutive years or longer, as described in Section 3.4.2.2. GPCO has sampled carbonyl compounds and VOCs under the NMP since 2004, PAHs since 2008, and metals since 2014; thus, Figures 7-23 through 7-33 present the 1-year statistical metrics for each of the pollutants of interest for GPCO except arsenic, since metals have not been sampled at this site for the minimum of 5 consecutive years. BRCO, PACO, and RICO began

sampling SNMOCs and carbonyl compounds under the NMP in 2008 and RFCO began sampling SNMOCs under the NMP in 2012. Thus, Figures 7-34 through 7-47 present the 1-year statistical metrics for each of the pollutants of interest for these sites.

The statistical metrics presented for assessing trends include the substitution of zeros for non-detects. If sampling began mid-year, a minimum of 6 months of sampling is required for inclusion in the trends analysis; in these cases, a 1-year average concentration is not provided, although the range and percentiles are still presented. While sampling at BMCO has occurred since late 2010, sampling has not been performed consecutively (with the 1-year temporary relocation to GSCO) and thus, a trends analysis was not conducted for BMCO (or GSCO).

Figure 7-23. Yearly Statistical Metrics for Acenaphthene Concentrations Measured at GPCO



[1] A 1-year average is not presented because sampling under the NMP did not begin until April 2008.

Observations from Figure 7-23 for acenaphthene concentrations measured at GPCO include the following:

- Sampling for PAHs at GPCO began under the NMP in April 2008. Because a full year's worth of data is not available for 2008, a 1-year average is not presented, although the range of measurements is provided.

- The maximum acenaphthene concentration (182 ng/m^3) was measured during the spring of 2012. The next highest concentration was measured during the summer of

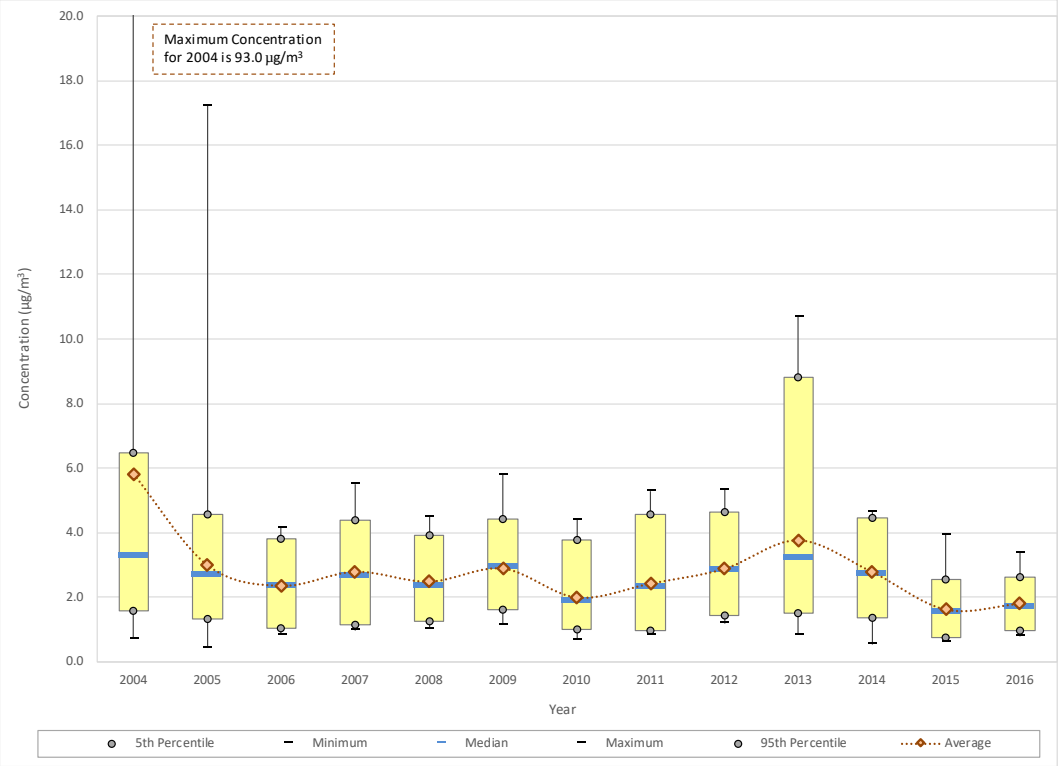
2015 (108 ng/m^3). Another acenaphthene concentration greater than 100 ng/m^3 measured at GPCO was also measured in 2012; five of the seven acenaphthene concentrations greater than 50 ng/m^3 were measured at GPCO in March and April of 2012.

- Concentrations of acenaphthene decreased significantly from 2009 to 2010, based on the 1-year averages, after which a steady increasing trend is shown through 2012. Concentrations measured in 2012 were higher overall compared to other years; nine of the 17 acenaphthene concentrations greater than 30 ng/m^3 were measured in 2012 while only one or two were measured in each of the other years of sampling (except 2014 and 2016 when none were measured). Even if the two highest concentrations measured in 2012 were removed from the dataset, the 1-year average concentration for acenaphthene for 2012 would still represent more than a 50 percent increase from 2011.

- All of the statistical metrics shown in Figure 7-23 exhibit a decrease for 2013. Both the 1-year average and median concentrations decreased by more than half from 2012 to 2013. Each of the statistical parameters exhibit additional decreases for 2014. The slight increase in the 1-year average concentration for 2015 is a result of the maximum concentration measured; if this data point is removed from the dataset, the 1-year average concentration would exhibit additional decreases. Even with the outlier, the 5th percentile and median concentration exhibit continued decreases for 2015.

- With the exception of the 95th percentile, all of the statistical parameters are at minimum for 2016; 2016 is the first year that an acenaphthene concentration greater than 20 ng/m^3 was not measured at GPCO.

Figure 7-24. Yearly Statistical Metrics for Acetaldehyde Concentrations Measured at GPCO



Observations from Figure 7-24 for acetaldehyde concentrations measured at GPCO include the following:

- The two highest acetaldehyde concentrations (93.0 µg/m^3 and 54.9 µg/m^3) were both measured at GPCO in 2004. The third highest acetaldehyde concentration (17.2 µg/m^3) was measured in 2005, after which acetaldehyde concentrations greater than 7 µg/m^3 were not measured again until 2013. In 2013, six concentrations ranging from 7.00 µg/m^3 to 10.7 µg/m^3 were measured.

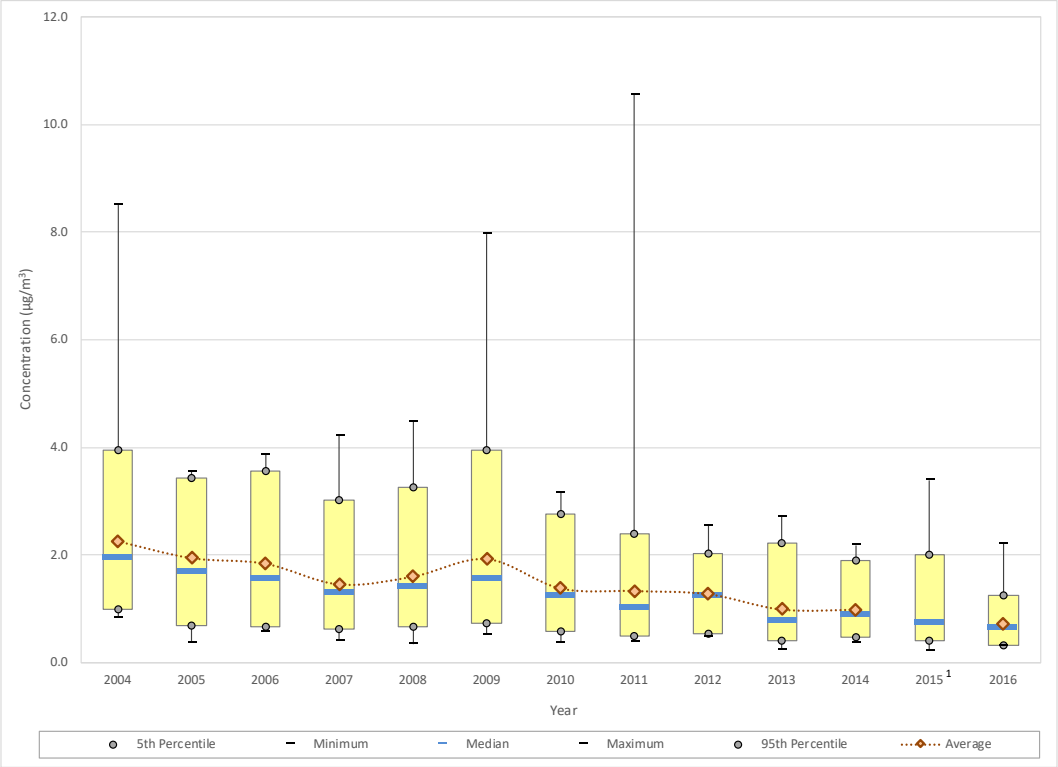
- Between 2005 and 2012, the 1-year average concentrations vary by less than 1 µg/m^3, ranging from 2.00 µg/m^3 (2010) to 3.00 µg/m^3 (2005). The largest year-to-year change shown is from 2009 to 2010. The 1-year average concentration increases significantly between 2010 and 2013, with the 1-year average at its highest since 2004. The median concentration exhibits a similar pattern.

- Concentrations measured in 2014 return to levels near those shown for 2012, with all of the statistical parameters exhibiting a decrease from 2013 to 2014. Additional decreases are shown for most of the parameters for 2015, when the 1-year average concentration is less than 2 µg/m^3 for the first time (1.63 µg/m^3).

- Even though the 1-year average and median concentrations increased slightly for 2016, the smallest range of acetaldehyde concentrations was measured at GPCO in 2016. Acetaldehyde concentrations greater than 4 µg/m^3 were not measured in 2015

or 2016. The 1-year average concentration for 2016 is also less than 2 µg/m^3 (1.81 µg/m^3).

Figure 7-25. Yearly Statistical Metrics for Benzene Concentrations Measured at GPCO



[1] A 1-year average is not presented for 2015 due to low completeness.

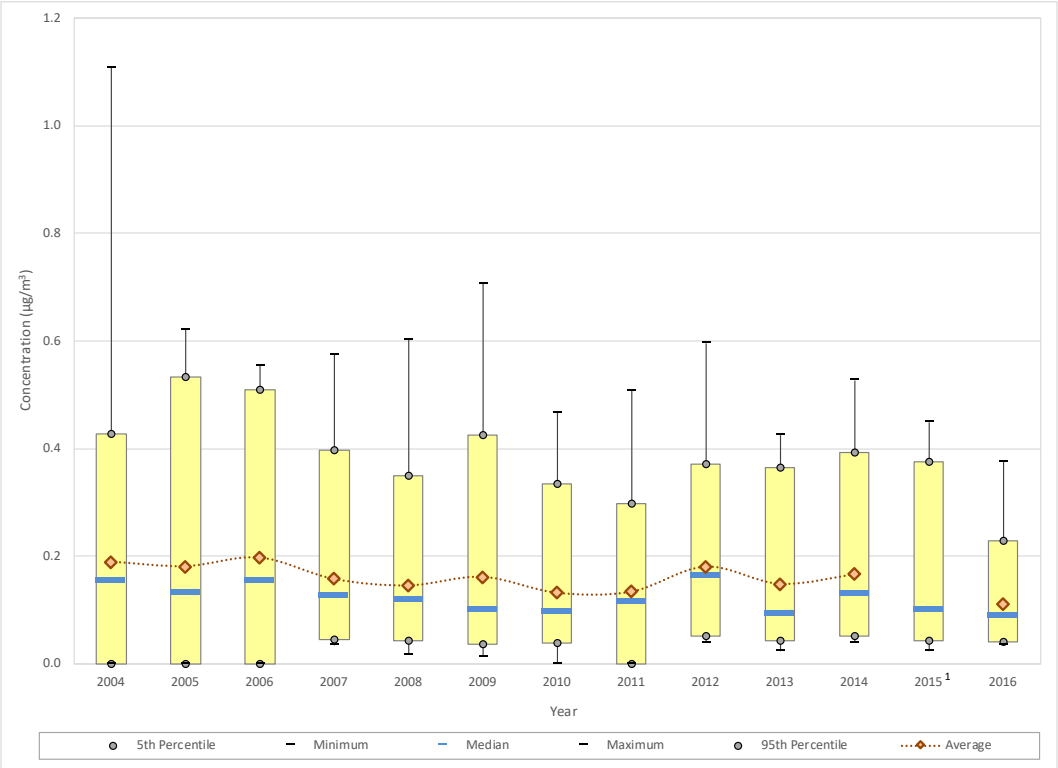
Observations from Figure 7-25 for benzene concentrations measured at GPCO include the following:

- The maximum benzene concentration (10.6 µg/m^3) was measured on June 8, 2011. Three additional benzene concentrations greater than 5 µg/m^3 have been measured at GPCO, two in 2004 and one in 2009.

- Concentrations of benzene have a decreasing trend between 2004 and 2007, based on the 1-year average concentration. After a period of increasing for 2008 and 2009, a significant decrease is shown for 2010. This decreasing trend continues through 2016, when the 1-year average concentration (and several of the other statistical metrics) is at a minimum. This is also true for the median concentration, except that the median increases slightly for 2014, before continuing to decrease.

- Although the range of benzene concentrations measured is at a minimum for 2014, the difference between the 5th and 95th percentiles is at a minimum for 2016 and is less than 1 µg/m^3 for the first time. This indicates that the majority of concentrations fell within the tightest range in 2016 (with the majority, or 90 percent, of benzene concentrations falling between 0.33 µg/m^3 and 1.24 µg/m^3).

Figure 7-26. Yearly Statistical Metrics for 1,3-Butadiene Concentrations Measured at GPCO



[1] A 1-year average is not presented for 2015 due to low completeness.

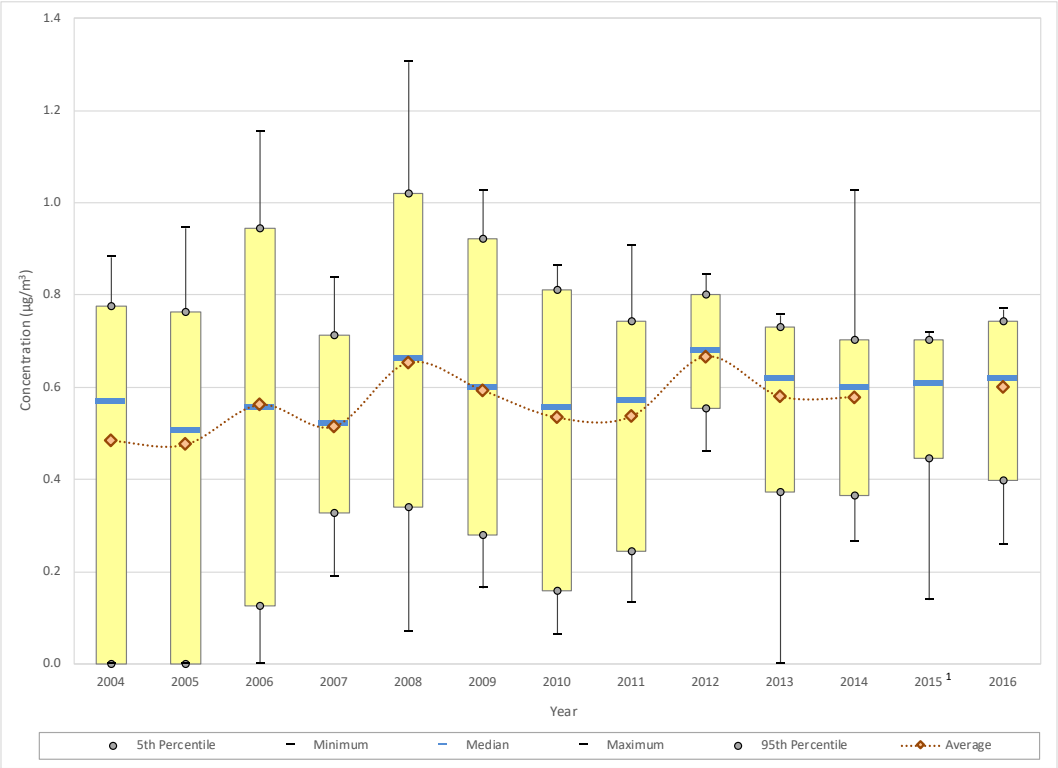
Observations from Figure 7-26 for 1,3-butadiene concentrations measured at GPCO include the following:

- The only 1,3-butadiene concentration greater than 1 µg/m^3 measured at GPCO was measured on December 11, 2004. The second highest concentration was also measured in 2004 (0.75 µg/m^3), although a similar concentration was measured in 2009 (0.71 µg/m^3).

- The 1-year average concentrations have an undulating pattern and vary by less than 0.09 µg/m^3 over the years of sampling, ranging from 0.110 µg/m^3 (2016) to 0.197 µg/m^3 (2006). The increase in the 1-year average concentration from 2011 to 2012 represents the largest year-to-year change (approximately 0.05 µg/m^3). The median also increased by this much from 2011 to 2012. Not only are the measurements at the upper end of the concentration range higher for 2012 compared to 2011 (three 1,3-butadiene concentrations greater than 0.3 µg/m^3 were measured in 2011 compared to nine in 2012), but there were also no non-detects reported for 2012, while there were seven reported for 2011. 2011 is the last year non-detects of 1,3-butadiene were reported at GPCO.

- Most of the statistical parameters exhibit decreases from 2014 to 2015 and again for 2016. The smallest range of 1,3-butadiene concentrations was measured at GPCO in 2016, when both the 1-year average and median concentrations are at a minimum.

Figure 7-27. Yearly Statistical Metrics for Carbon Tetrachloride Concentrations Measured at GPCO



[1] A 1-year average is not presented for 2015 due to low completeness.

Observations from Figure 7-27 for carbon tetrachloride concentrations measured at GPCO include the following:

- Seven concentrations of carbon tetrachloride greater than 1 µg/m^3 have been measured at GPCO (four in 2008, and one each in 2006, 2009, and 2014). Conversely, 16 non-detects have been measured (nine in 2004, five in 2005, and one each in 2006 and 2013).

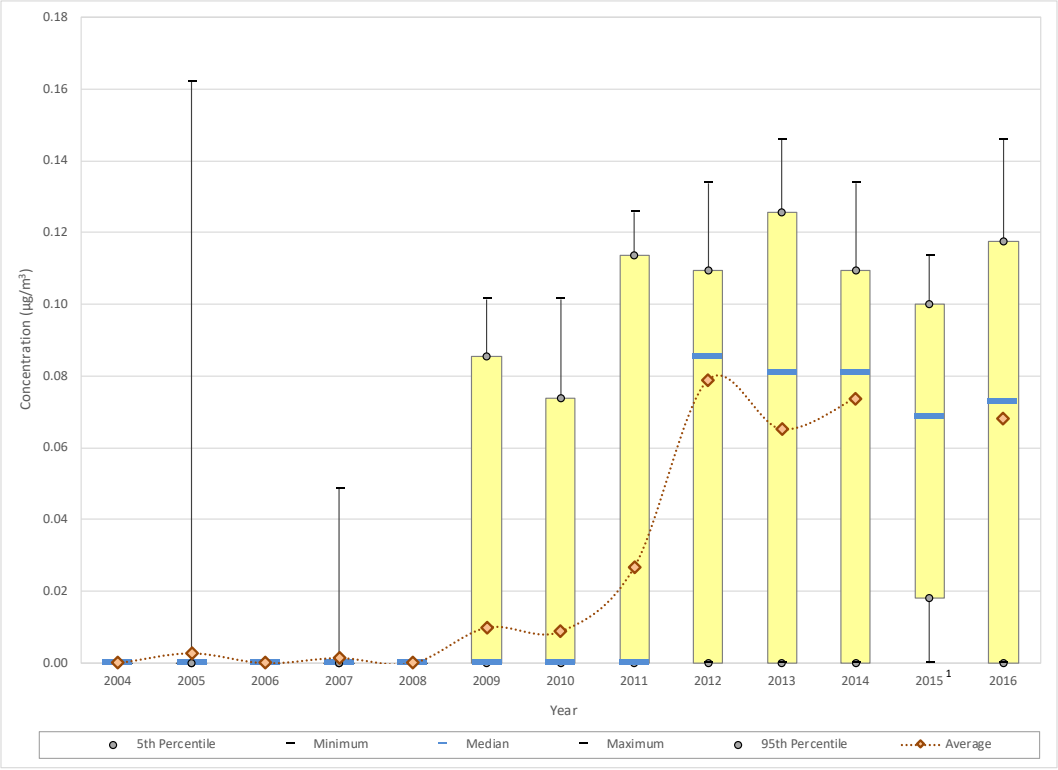
- The year with the least variability is 2012, with a difference of 0.38 µg/m^3 between the minimum and maximum concentrations and a difference of 0.24 µg/m^3 between the 5th and 95th percentiles. However, the year with the highest 1-year average and median concentrations (0.67 µg/m^3 and 0.68 µg/m^3, respectively) is also 2012. Note that the 5th percentile for 2012 is greater than or similar to the 1-year average and/or median concentrations for several of the previous years of sampling.

- For most of the years of sampling, the median concentration is slightly higher than the 1-year average concentration. This indicates that the concentrations at the lower end of the concentration range are pulling down the 1-year average in the same manner than an outlier can drive an average upward. However, the difference between the 1-year average and median concentrations for most years is less than 0.05 µg/m^3.

- There is a significant increase in the 1-year average concentrations from 2007 to 2008 as the range of concentrations measured doubled from one year to the next. After 2008, a decreasing trend is shown through 2010, with little change in the 1-year average from 2010 to 2011. These statistical parameters increased significantly from 2011 to 2012, and are at a maximum for the period of sampling. All of the statistical metrics exhibit a decrease from 2012 to 2013, primarily as a result of the higher number of concentrations at the lower end of the concentration range. The number of carbon tetrachloride concentrations less than 0.5 µg/m^3 increased from one in 2012 to 12 in 2013.

- Between 2013 and 2016, the central tendency statistics change little, with both the 1-year average and median concentrations varying by about 0.02 µg/m^3 across these four years.

Figure 7-28. Yearly Statistical Metrics for 1,2-Dichloroethane Concentrations Measured at GPCO



[1] A 1-year average is not presented for 2015 due to low completeness.

Observations from Figure 7-28 for 1,2-dichloroethane concentrations measured at GPCO include the following:

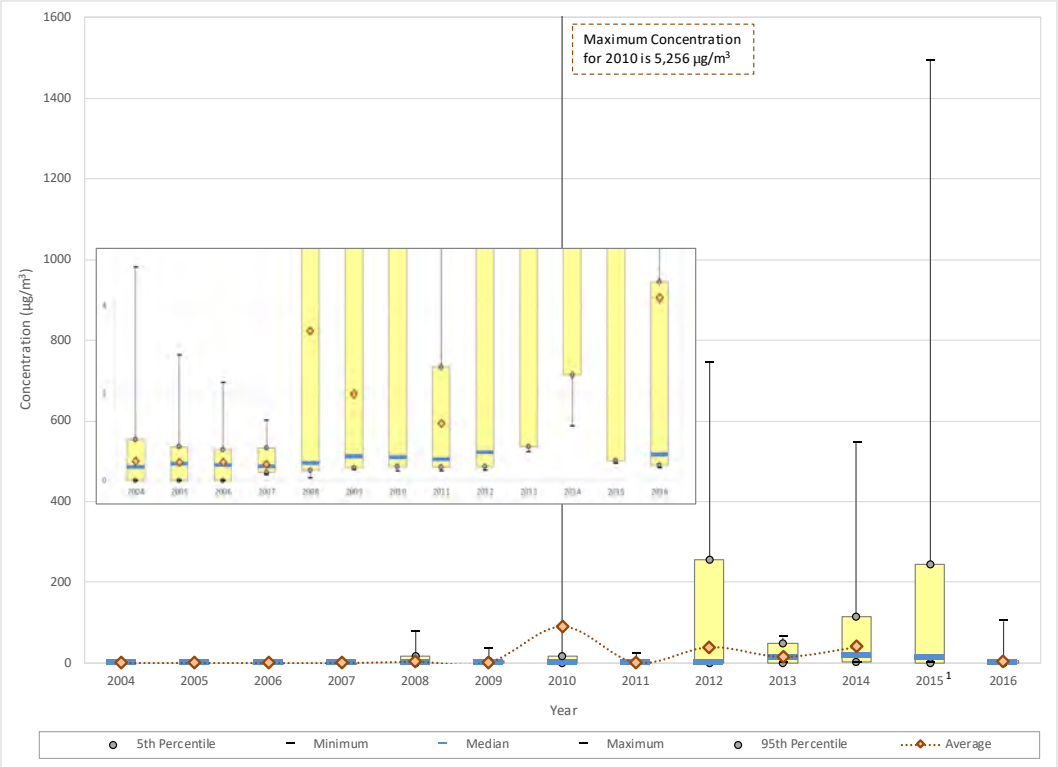
- Between 2004 and 2008, there were only three measured detections of 1,2-dichloroethane measured at GPCO. The median concentration is zero for all years through 2011, indicating that at least 50 percent of the measurements were non-detects prior to 2012. The number of measured detections began to increase in 2009, from 12 percent for 2009 and 2010, to 27 percent in 2011, and 90 percent for 2012.

Since 2012, measured detections have accounted for the majority of measurements, ranging from 74 percent in 2013 to 94 percent in 2015.

- As the number of measured detections increases, so do each of the corresponding statistical metrics shown in Figure 7-28. The percentage of measured detections increased by 64 percent from 2011 to 2012, thus, the 1-year average and median concentrations exhibit considerable increases.

- The median concentration is greater than the 1-year average concentration for each year after 2011. This is because there are still non-detects (or zeros) factoring into the 1-year average concentration for each year, which pull the average down in the same manner than an outlier drives an average upward. Excluding non-detects, the minimum concentration for each year between 2012 and 2016 would range from 0.03 µg/m^3 to 0.05 µg/m^3.

Figure 7-29. Yearly Statistical Metrics for Dichloromethane Concentrations Measured at GPCO



[1] A 1-year average is not presented for 2015 due to low completeness.

Observations from Figure 7-29 for dichloromethane concentrations measured at GPCO include the following:

- Due to the range of concentrations measured, Figure 7-29 contains an inset showing how the statistical metrics look at the lower end of the scale.

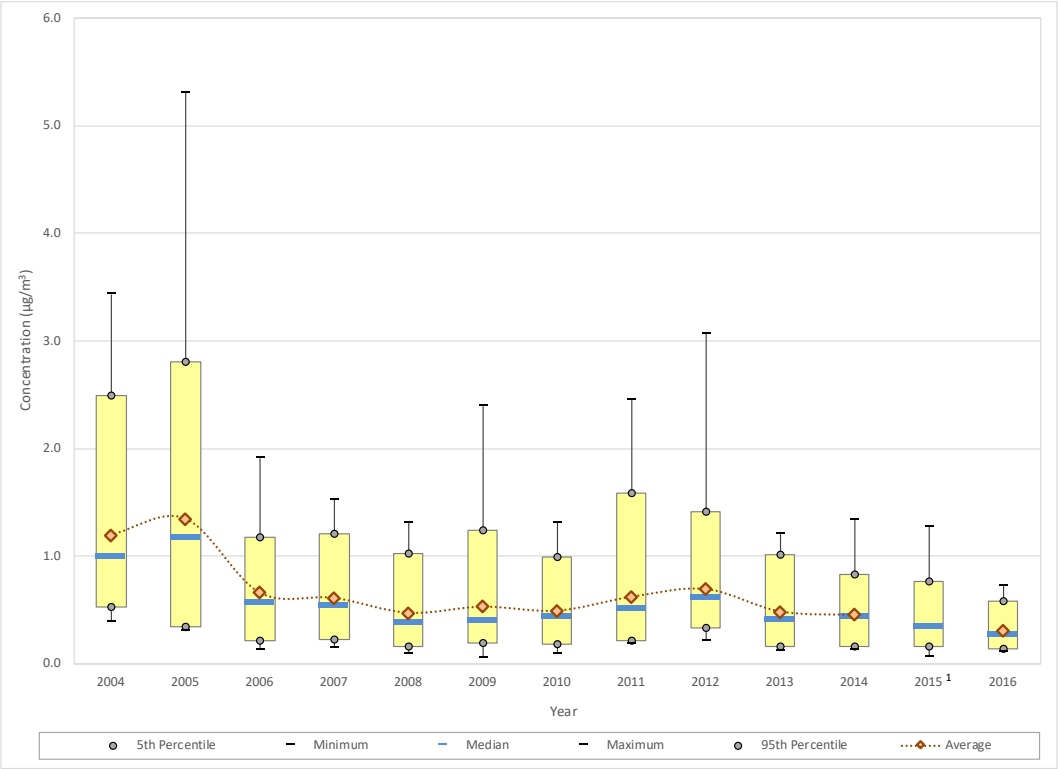
- The maximum dichloromethane concentration was measured at GPCO in 2010 (5,256 µg/m^3); an additional concentration greater than 1,000 µg/m^3 was also

measured in 2015 (1,493 µg/m^3). In total, 21 concentrations of dichloromethane greater than 100 µg/m^3 have been measured at this site, all of which were measured in 2010 or later.

- The central tendency statistics vary little during the early years of sampling, as shown in the inset, with less than 0.1 µg/m^3 separating the 1-year average concentrations. Between 2008 and 2016, the 1-year average concentrations range from as little as 1.32 µg/m^3 (2011) to as high as 91.79 µg/m^3 (2010).

- The median concentration holds steady between 2004 and 2008, ranging from 0.31 µg/m^3 (2004) to 0.40 µg/m^3 (2008). Between 2009 and 2012, the median concentrations vary slightly more, ranging from 0.49 µg/m^3 (2011) to 0.65 µg/m^3 (2012). The median increases considerably, in a similar manner as the 1-year average concentration, for the years between 2013 and 2015. For 2016, the median decreases back to level similar 2008-2012 levels.

Figure 7-30. Yearly Statistical Metrics for Ethylbenzene Concentrations Measured at GPCO



[1] A 1-year average is not presented for 2015 due to low completeness.

Observations from Figure 7-30 for ethylbenzene concentrations measured at GPCO include the following:

- The maximum ethylbenzene concentration was measured at GPCO in 2005 (5.31 µg/m^3), as was the second highest concentration (3.96 µg/m^3). Three additional concentrations greater than 3 µg/m^3 have been measured at GPCO, two in 2004 and

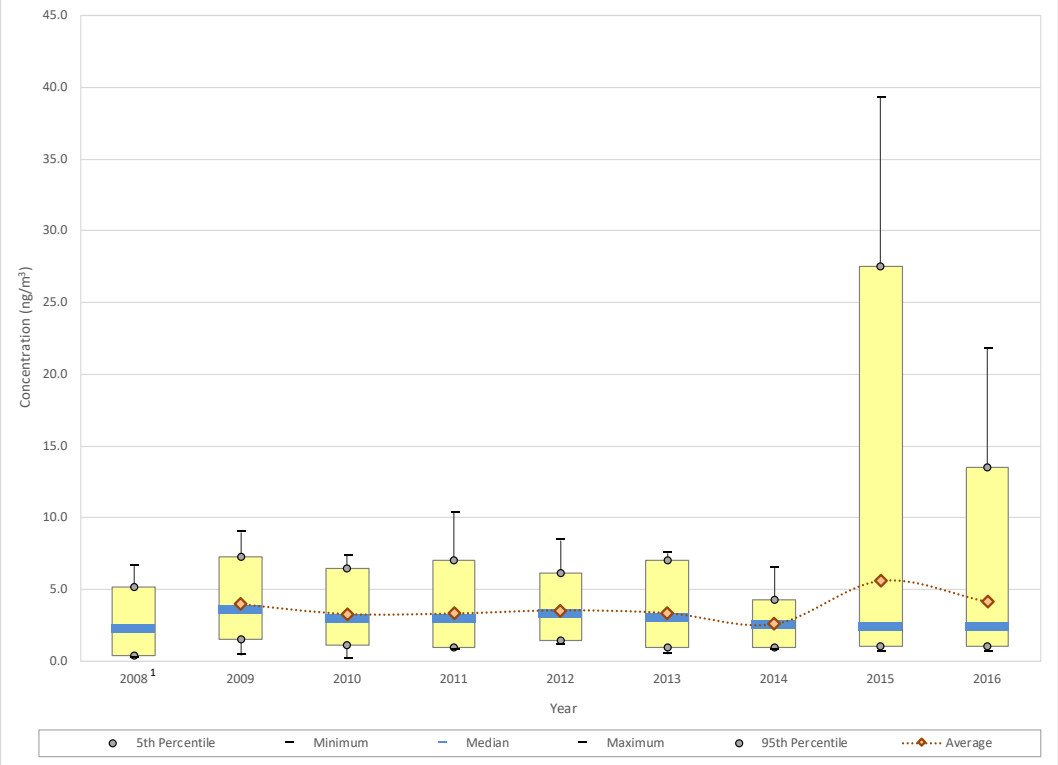
one in 2012. All but two of the 18 ethylbenzene measurements greater than 2 µg/m^3 were measured during these three years.

- The 1-year average concentration increased from 2004 to 2005, although there is a relatively high level of variability in the measurements. A significant decrease in all the statistical parameters is shown from 2005 to 2006, with a slight decreasing trend continuing through 2008.

- Although the maximum concentration measured increased by more than 1 µg/m^3 from 2008 to 2009, only a slight change in the 1-year and median concentrations is exhibited for 2009. The range of concentrations measured in 2010 is similar to the range of concentrations measured in 2008. An increasing trend in the 1-year average concentration is shown from 2010 through 2012. The median concentration begins increasing in 2009 and continues through 2012.

- All of the statistical parameters exhibit a decrease from 2012 to 2013, with the maximum concentration decreasing by more than half. Between 2013 and 2016, the 95th percentile decreased at least slightly each year, indicating that the range within which the majority of concentrations fall is getting tighter. With the exception of the minimum concentration, all of the statistical parameters are at a minimum for 2016.

Figure 7-31. Yearly Statistical Metrics for Fluoranthene Concentrations Measured at GPCO



[1] A 1-year average is not presented because sampling under the NMP did not begin until April 2008.

Observations from Figure 7-31 for fluoranthene concentrations measured at GPCO include the following:

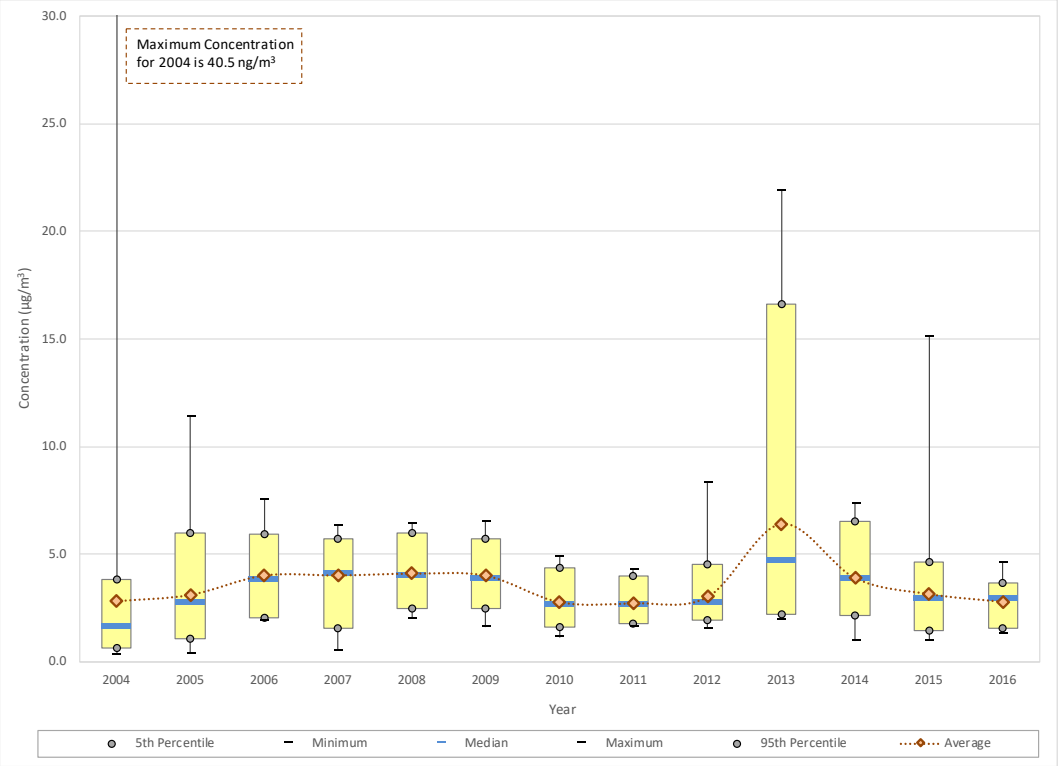
- There is little change is the fluoranthene concentrations measured between 2009 (the first full year of sampling) and 2013. The 1-year average concentration varies by less than 1 ng/m^3 during this time, ranging from 3.30 ng/m^3 in 2010 to 3.98 ng/m^3 in 2009.

- A decrease in most of the statistical parameters is shown for 2014, when the smallest range of fluoranthene concentrations was measured at GPCO.

- The range of fluoranthene concentrations increased dramatically in 2015, which is the first year that a fluoranthene concentration greater than 15 ng/m^3 was measured at GPCO. The 1-year average concentration for 2015 is greater than the 95th percentile for 2014. However, the median concentration for 2015 is the lowest median since the first full year of sampling. This indicates that the higher fluoranthene concentrations are driving the 1-year average concentration for 2015, while concentrations on the lower end of the concentration range account for about half of the measurements for GPCO in 2015. The number of fluoranthene concentrations less than 2.5 ng/m^3 is the same for 2014 as it is for 2015 (29).

- The statistical parameters representing the concentrations on the upper end of the range exhibit decreases for 2016 and thus, the 1-year average concentration decreased for 2016. But the median concentration for 2016 is similar to the median concentration for 2015, and the number of concentrations less than 2.5 ng/m^3 is at a maximum (33).

Figure 7-32. Yearly Statistical Metrics for Formaldehyde Concentrations Measured at GPCO



Observations from Figure 7-32 for formaldehyde concentrations measured at GPCO include the following:

- The maximum formaldehyde concentration (40.5 µg/m^3) was measured in 2004 and is significantly higher than the maximum concentrations measured in subsequent years. The second highest concentration was also measured in 2004 (23.5 µg/m^3); these two concentrations of formaldehyde were measured on the same back-to-back days in 2004 as the two highest acetaldehyde concentrations. The next seven highest formaldehyde concentrations were measured at GPCO in 2013 and range from 15.8 µg/m^3 to 21.9 µg/m^3. The only other formaldehyde concentration greater than 15 µg/m^3 was measured at GPCO in 2015.

- Even with decreasing maximum concentrations, the 1-year average concentrations have an increasing trend through 2006. The 1-year average concentration is approximately 4 µg/m^3 for each year between 2006 and 2009. A significant decrease in all of the statistical parameters is shown for 2010. Although an even smaller range of concentrations was measured in 2011, there is little change in the 1-year average concentration between 2010 and 2011. With a few higher concentrations measured in 2012, the 1-year average calculated for 2012 is slightly higher than the 1-year average concentrations for the previous two years, although the increase is not statistically significant.

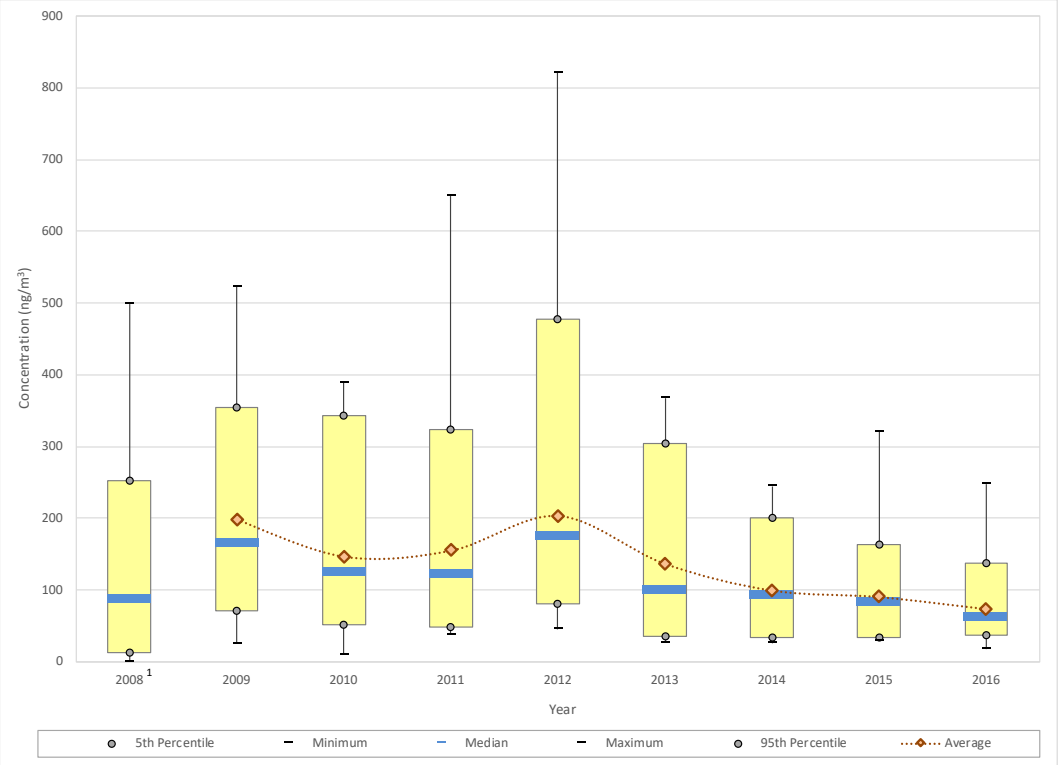
- All of the statistical parameters exhibit increases for 2013, particularly those representing concentrations at the upper end of the concentration range. The 1-year

average concentration for 2013 is greater than the maximum concentrations measured in several of the previous years and is greater than the 95th percentile for each of the previous years. Even the median concentration, which is less affected by outlier concentrations, increased by more than 70 percent from 2012 to 2013. Ten formaldehyde concentrations measured in 2013 are greater than the maximum concentration measured in 2012; further, the number of formaldehyde concentrations greater than 5 µg/m^3 increased from two in 2012 to 26 in 2013.

- All of the statistical metrics for 2014 exhibit a decrease from 2013 levels, although the 1-year average and median concentrations are still higher than they were in the three years prior to 2013. The 1-year average formaldehyde concentration continues to decrease each year through 2016.

- For 2016, the difference between the 5th and 95th percentiles is at a minimum, indicating that the majority of concentrations fell into the tightest range in 2016.

Figure 7-33. Yearly Statistical Metrics for Naphthalene Concentrations Measured at GPCO



[1] A 1-year average is not presented because sampling under the NMP did not begin until April 2008.

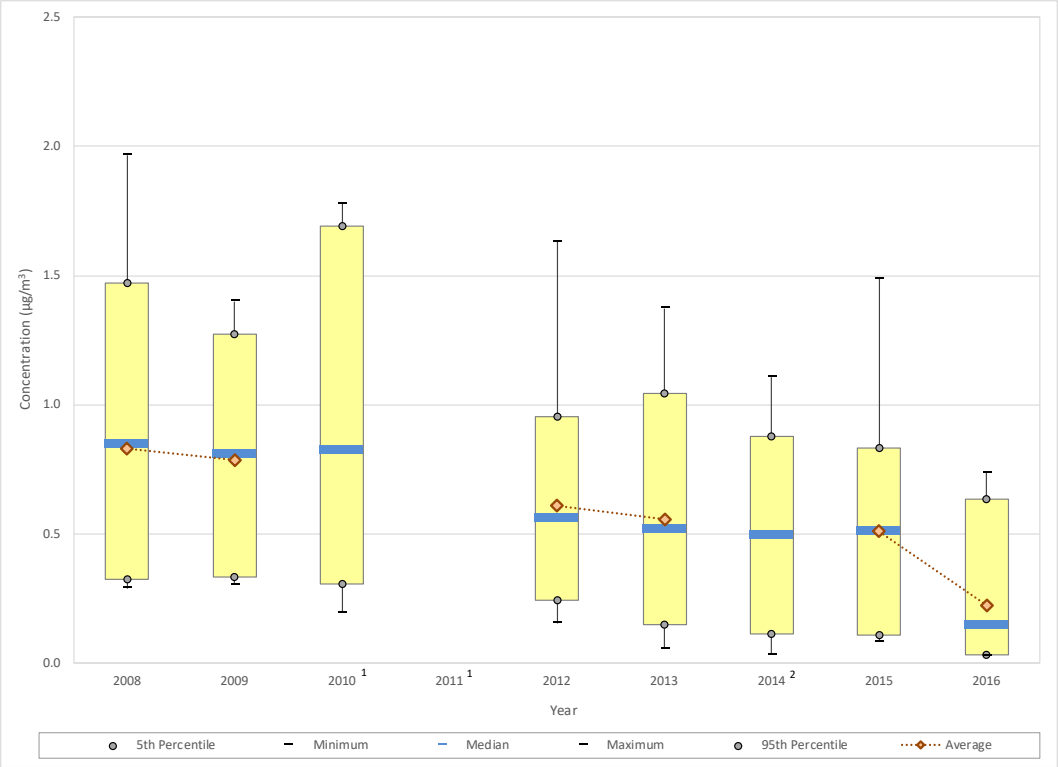
Observations from Figure 7-33 for naphthalene concentrations measured at GPCO include the following:

- The maximum naphthalene concentration measured at GPCO was measured in 2012 (822 ng/m^3). Concentrations of 400 ng/m^3 or higher have been measured in four of the years of sampling and concentrations greater than 250 ng/m^3 have been measured in all years of sampling except 2014 and 2016.

- The trends graph for naphthalene resembles the trends graphs for acenaphthene shown in Figure 7-23. The 1-year average concentration for naphthalene decreased significantly from 2009 to 2010. A slight increase from 2010 to 2011 is followed by an additional increase for 2012. All of the statistical parameters increased from 2011 to 2012 and are at a maximum across the years of sampling.

- A significant decreasing trend is shown after 2012. Both the 1-year average and median concentrations are at a minimum for 2016, with the 1-year average concentration decreasing by nearly half between 2012 and 2016.

Figure 7-34. Yearly Statistical Metrics for Acetaldehyde Concentrations Measured at BRCO



[1] There was a gap in sampling between October 2010 and September 2011.
[2] A 1-year average is not presented due to low method completeness in 2014.

Observations from Figure 7-34 for acetaldehyde concentrations measured at BRCO include the following:

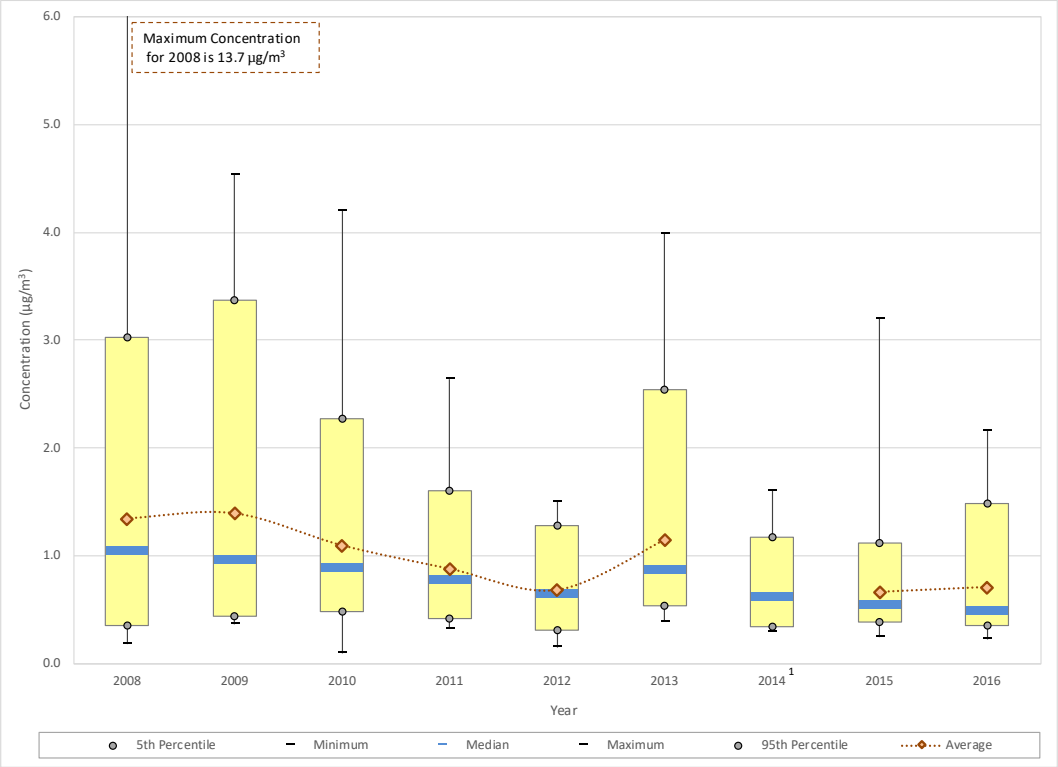
- BRCO began sampling carbonyl compounds under the NMP in February 2008. A 1-year average concentration is not presented for 2010 and statistical metrics are not provided for 2011 because sampling was discontinued in October 2010 and did not begin again until September 2011. In addition, the completeness criteria was not met for 2014, and thus, a 1-year average concentration is not provided for 2014. Note that carbonyl compounds are sampled on a 1-in-12 sampling schedule at BRCO.

- The maximum acetaldehyde concentration (1.97 µg/m^3) was measured on the second day of sampling, February 12, 2008. In total, only 28 acetaldehyde concentrations

greater than 1 µg/m^3 have been measured at BRCO since the onset of sampling, with none measured in 2016.

- Concentrations of acetaldehyde measured at BRCO have a decreasing trend across the years of sampling, and all of the statistical parameters are at a minimum for 2016.

Figure 7-35. Yearly Statistical Metrics for Benzene Concentrations Measured at BRCO



[1] A 1-year average is not presented due to low method completeness in 2014.

Observations from Figure 7-35 for benzene concentrations measured at BRCO include the following:

- BRCO began sampling benzene under the NMP in January 2008. Similar to acetaldehyde, a 1-year average concentration is not provided for benzene for 2014 as the completeness criteria was not met.

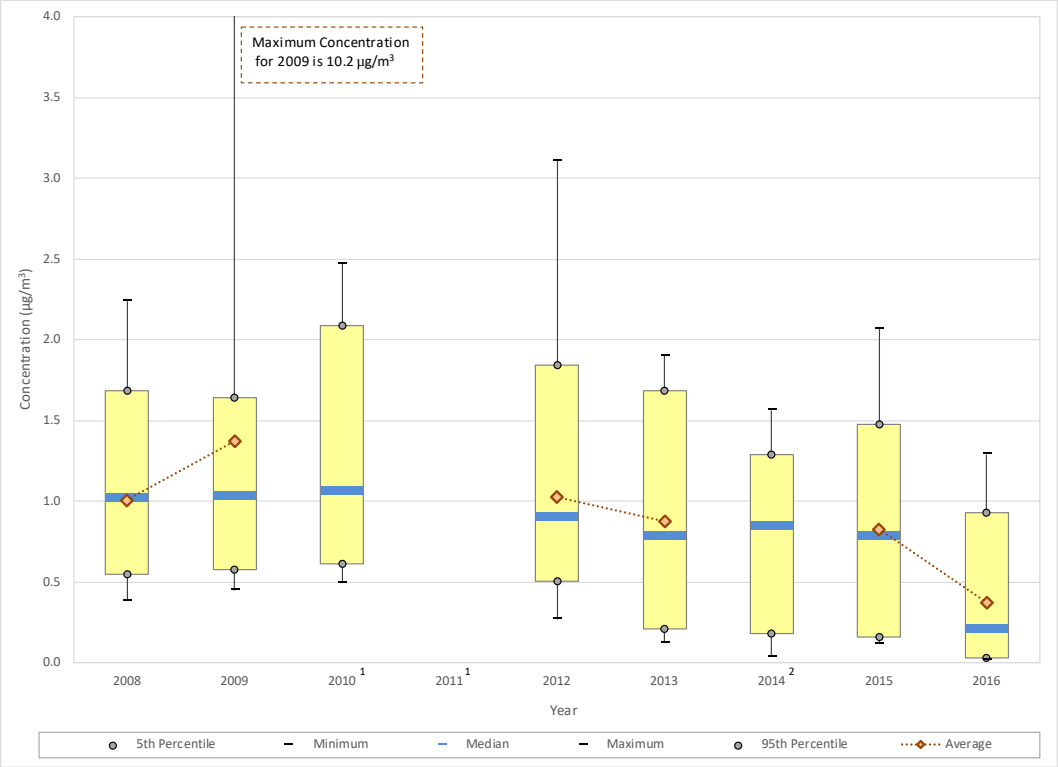
- The maximum benzene concentration (13.7 µg/m^3) was measured on July 29, 2008 and is three times greater than the next highest concentration (4.55 µg/m^3, measured on January 7, 2009). Two additional benzene concentrations greater than 4 µg/m^3 have been measured at BRCO, another in 2009 and one in 2010.

- Most of the statistical parameters for benzene exhibit a steady decreasing trend over the years of sampling at BRCO between 2009 and 2012. Prior to 2013, the 1-year average concentration decreased by roughly half, from a maximum of 1.39 µg/m^3 in 2009 to a minimum of 0.68 µg/m^3 in 2012. The median concentration also has a decreasing trend, and has decreased each year between 2008 and 2012, from 1.05 µg/m^3 in 2008 to 0.65 µg/m^3 in 2012.

- All of the statistical metrics exhibit an increase from 2012 to 2013, returning to concentration levels similar to 2010. The fewest benzene concentrations less than 0.5 µg/m^3 were measured in 2013 (two), compared to 18, or about one-third of the measurements, in 2012. The increases for 2013 are followed by a return to 2012 levels for 2014, based on the available statistical metrics. Additional slight decreases are shown for several of the statistical parameters for 2015.

- Even though the 1-year average concentration for 2016 exhibits a slight increase, the median concentration continues to decrease, and is at a minimum for 2016 over the period of sampling; 2016 is the first year for which the median concentration is less than 0.5 µg/m^3.

Figure 7-36. Yearly Statistical Metrics for Formaldehyde Concentrations Measured at BRCO



[1] There was a gap in sampling between October 2010 and September 2011.
[2] A 1-year average is not presented due to low method completeness in 2014.

Observations from Figure 7-36 for formaldehyde concentrations measured at BRCO include the following:

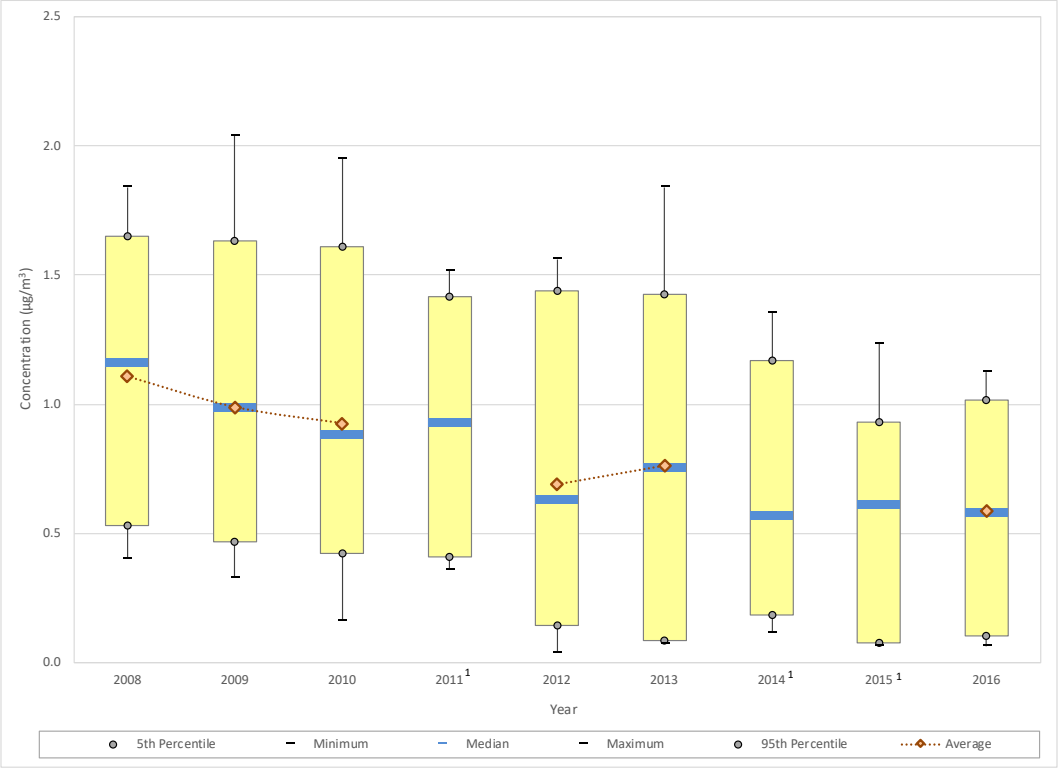
- The maximum formaldehyde concentration (10.2 µg/m^3) was measured at BRCO on January 7, 2009, the same day as the second highest benzene concentration. This formaldehyde measurement is more than three times higher than the next highest concentration measured at this site (3.11 µg/m^3, measured on August 31, 2012). Four additional formaldehyde concentrations greater than 2.0 µg/m^3 have been measured at BRCO.

- The increase in the 1-year average concentration shown from 2008 to 2009 results primarily from the maximum concentration measured in 2009. The median concentrations are similar to each other for these two years (1.02 µg/m^3 and 1.03 µg/m^3) and, if the maximum concentration for 2009 was removed from the dataset, the 1-year average concentrations would also be similar to each other.

- Several of the statistical parameters exhibit increases for 2010, although these parameters do not include measurements for an entire year.

- Between 2012 and 2016 there is an overall decreasing trend in the formaldehyde concentrations measured at BRCO. Nearly all of the statistical parameters are at a minimum for 2016, when only one formaldehyde concentration greater than 1 µg/m^3 was measured.

Figure 7-37. Yearly Statistical Metrics for Acetaldehyde Concentrations Measured at PACO



[1] A 1-year average is not presented due to low method completeness in 2011, 2014, and 2015.

Observations from Figure 7-37 for acetaldehyde concentrations measured at PACO include the following:

- PACO began sampling acetaldehyde under the NMP in February 2008. A 1-year average concentration is not presented for 2011 due to low method completeness. This is also true for 2014 and 2015. Note that carbonyl compounds are sampled on a 1-in-12 sampling schedule at PACO.

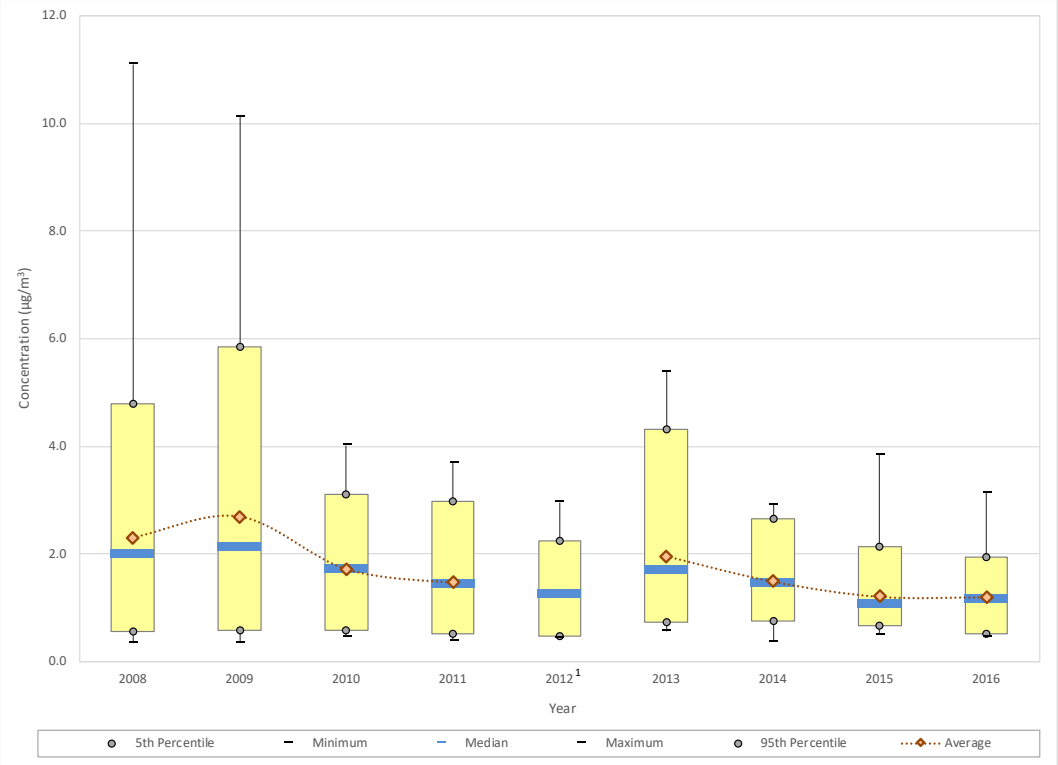
- The maximum acetaldehyde concentration (2.04 µg/m^3) was measured at PACO on January 13, 2009 and is the only acetaldehyde concentration greater than 2 µg/m^3 measured at this site.

- Acetaldehyde concentrations measured at PACO have an overall decreasing trend through 2016 (although two of the years do not follow this pattern, and are discussed in the bullets that follow). The 1-year average concentration is at a minimum for 2016, though several of the years do not have 1-year averages presented. The median concentration, which is available for each year of sampling, is at a minimum for 2014, although the median concentrations for 2015 and 2016 are similar.

- Concentrations greater than 1 µg/m^3 make up a higher percentage of the measurements in 2011, compared to 2010 and 2012, resulting in a higher median concentration. In addition, the minimum concentration measured in 2011 was higher than most other years of sampling; 2011 also has fewer concentrations less than 0.5 µg/m^3 than most other years.

- For 2013, both the 1-year average and median concentrations exhibit an increase. The largest range of acetaldehyde concentrations was measured in 2013, and the range within which the majority of the measurements fall, indicated by the 5th and 95th percentiles, is at a maximum for 2013 over the years of sampling.

Figure 7-38. Yearly Statistical Metrics for Benzene Concentrations Measured at PACO



[1] A 1-year average is not presented due to low method completeness in 2012.

Observations from Figure 7-38 for benzene concentrations measured at PACO include the following:

- PACO began sampling SNMOCs under the NMP in January 2008. A 1-year average concentration is not presented for 2012 due to low method completeness resulting from issues with the collection system.

- The maximum benzene concentration (11.1 µg/m^3) was measured at PACO on October 15, 2008. The next highest measurement (10.1 µg/m^3) was measured 3 months later on January 7, 2009. The third highest concentration was measured on the next sample day in 2009 (7.52 µg/m^3). In total, 12 benzene concentrations greater than 5.0 µg/m^3 have been measured at PACO, with three measured in 2008, eight measured in 2009, and one in 2013.

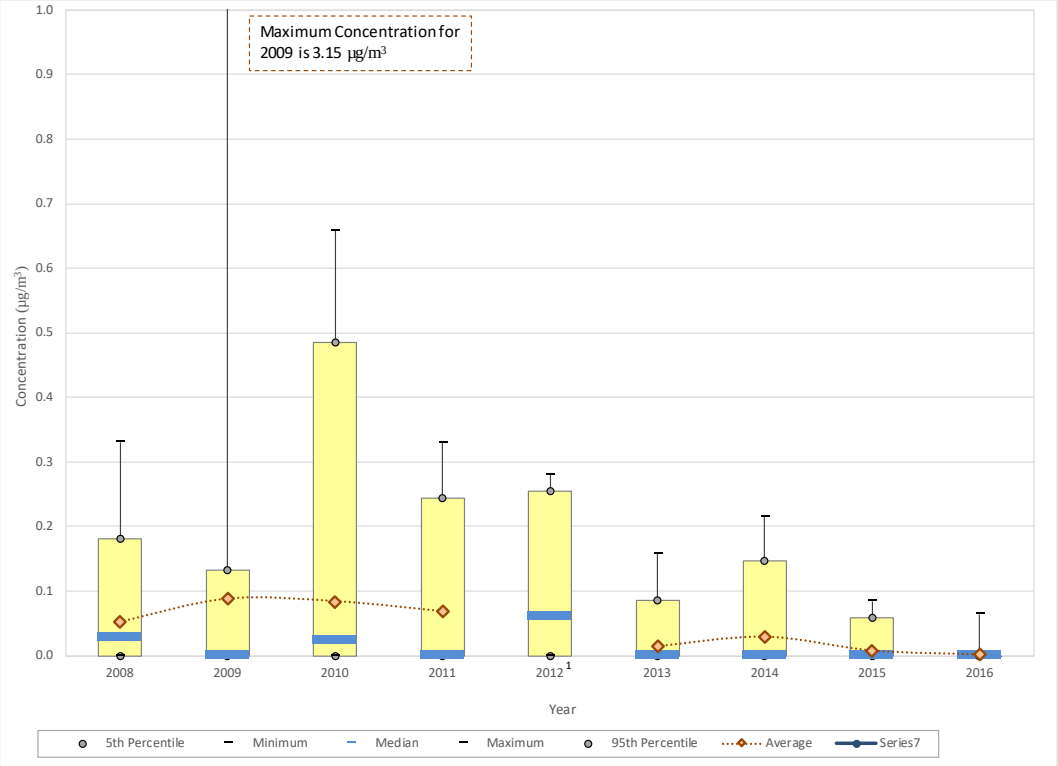
- Even though the maximum concentration decreased some from 2008 to 2009, benzene concentrations increased overall from 2008 to 2009, as indicated by the increases in the 1-year average, median, and 95th percentile.

- Concentrations of benzene decreased significantly between 2009 and 2010, when the maximum and 95th percentile decreased by nearly half. This decreasing trend continued into 2011 and 2012. Benzene concentrations greater than 3 µg/m^3 were not measured in 2012.

- All of the statistical parameters shown exhibit considerable increases from 2012 to 2013. The range within which the majority of the measurements fall, indicated by the 5th and 95th percentiles, more than doubled and is at its largest since 2009. Nine benzene concentrations greater than the maximum concentration for 2012 (2.97 µg/m^3) were measured in 2013.

- The increases shown for 2013 were followed by significant decreases over the last three years of sampling. The 1-year average concentration is at a minimum for 2016 while the median concentration is at a minimum for 2015.

Figure 7-39. Yearly Statistical Metrics for 1,3-Butadiene Concentrations Measured at PACO



[1] A 1-year average is not presented due to low method completeness in 2012.

Observations from Figure 7-39 for 1,3-butadiene concentrations measured at PACO include the following:

- The maximum 1,3-butadiene concentration (3.15 µg/m^3) was measured on December 27, 2009 and is the only 1,3-butadiene measurement greater than 1 µg/m^3 measured at this site.

- The increase in the 1-year average concentration from 2008 to 2009 is a result of this outlier concentration measured in 2009. The second highest concentration measured in 2009 is substantially less (0.188 µg/m^3). Excluding the maximum concentration for 2009 would result is a 1-year average concentration of only 0.028 µg/m^3 (rather than 0.088 µg/m^3), and thus, a decrease in the 1-year average concentration by almost half from 2008 to 2009. Note that the median 1,3-butadiene concentration for 2009 is zero, indicating that at least half of the measurements for 2009 are non-detects.

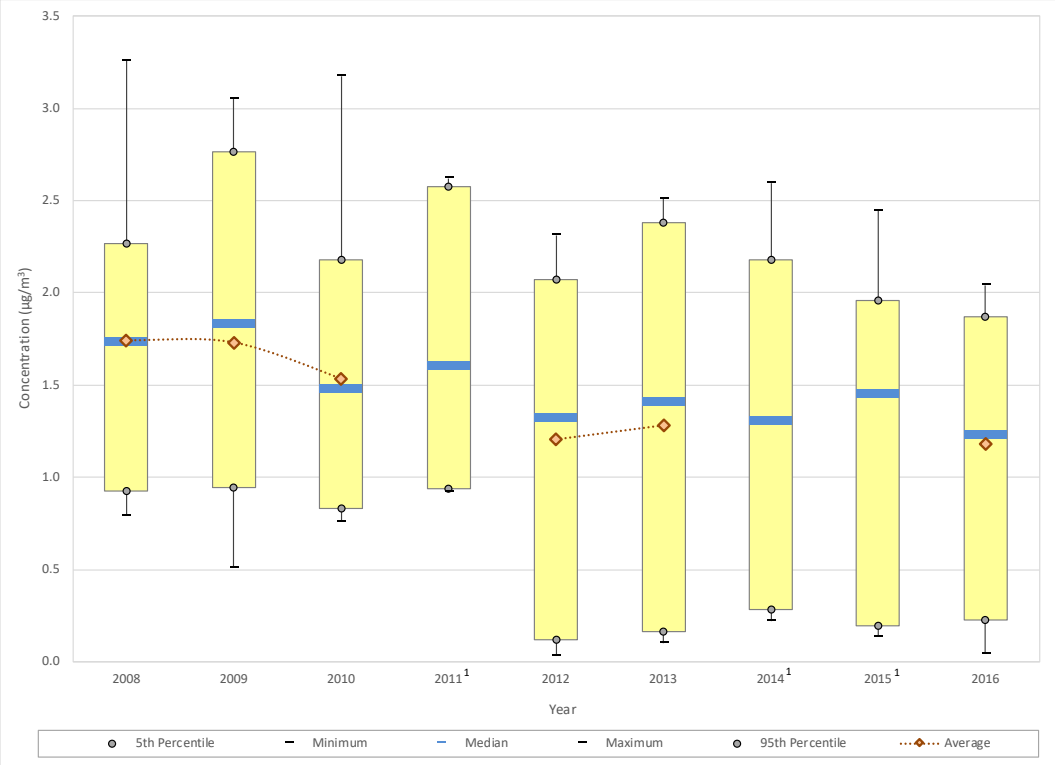
- The second, third, fourth, and fifth highest 1,3-butadiene concentrations measured at PACO were all measured in December 2010 and range from 0.39 µg/m^3 to 0.66 µg/m^3. The next two highest concentrations for this year was also measured in December but were considerably less (0.16 µg/m^3 and 0.12 µg/m^3). The 95th percentile for 2010 is greater than the maximum concentration measured for all other years except 2009, when the outlier was measured. Even though half of the measurements in 2010 were non-detects, the December measurements for 2010 are driving the top-end statistical parameters upward.

- Nearly all of the statistical parameters decreased from 2010 to 2011, except the minimum and 5th percentile, which are both zero for these years.

- Prior to 2012, the percentage of non-detects of 1,3-butadiene measured at PACO ranged from 47 percent (2008) to 58 percent (2009 and 2011). This explains why the median concentration is at or near zero for these years. For 2012, the number of non-detects is at a minimum (29 percent) and explains why the median increased considerably, although the range of measurements did not change much from 2011 and 2012.

- For 2013, the median concentration returned to zero as the number of non-detects increased from 29 percent in 2012 to 83 percent for 2013. Between 2013 and 2016, the percentage of non-detects is greater than 75 percent for each year, with the percentage of non-detects reaching a maximum of 96 percent in 2016. With only two measured detections, and 52 zeros factoring in for non-detects, it's not surprising that the 1-year average concentration for 2016 is considerably lower than the other 1-year average concentrations shown in Figure 7-39.

Figure 7-40. Yearly Statistical Metrics for Formaldehyde Concentrations Measured at PACO



[1] A 1-year average is not presented due to low method completeness in 2011, 2014, and 2015.

Observations from Figure 7-40 for formaldehyde concentrations measured at PACO include the following:

- Four formaldehyde concentrations greater than 3 µg/m^3 have been measured at PACO (one in 2008, two in 2009, and one in 2010).

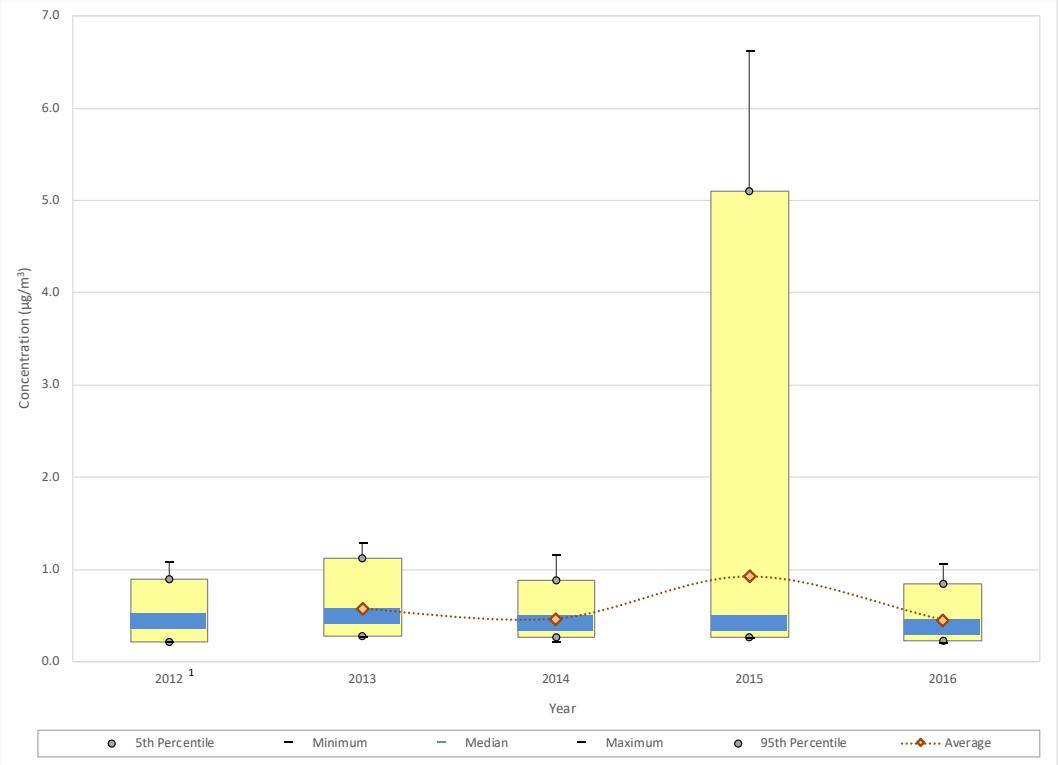
- The 1-year average concentration changed little between 2008 and 2009. The decreases in the minimum and maximum concentrations for 2009 are countered by an increase in the number of measurements at the higher end of the concentration range, as indicated by the increases in the median and 95th percentile.

- The data distribution statistics for 2010 resemble those for 2008, although the 1-year average and median concentrations both exhibit decreases. The number of formaldehyde concentrations greater than 2 µg/m^3 decreased by more than half from 2009 to 2010, while the number of concentrations less than 1 µg/m^3 more than doubled.

- Although the maximum concentration decreased for 2011, all of the other statistical parameters that could be calculated exhibit increases from 2010 to 2011.

- All of the statistical parameters exhibit decreases from 2011 to 2012, particularly at the lower end of the concentration range, as the 5th percentile decreased from just less than 1 µg/m^3 to just greater than 0.1 µg/m^3. The concentration profiles for the four years following 2012 more resemble 2012 than the four years prior. Less than 0.25 µg/m^3 separates the median concentrations for 2012 through 2016, and approximately 0.10 µg/m^3 separates the available 1-year average concentrations for these years.

Figure 7-41. Yearly Statistical Metrics for Benzene Concentrations Measured at RFCO



[1] A 1-year average is not presented because sampling did not begin until June 2012.

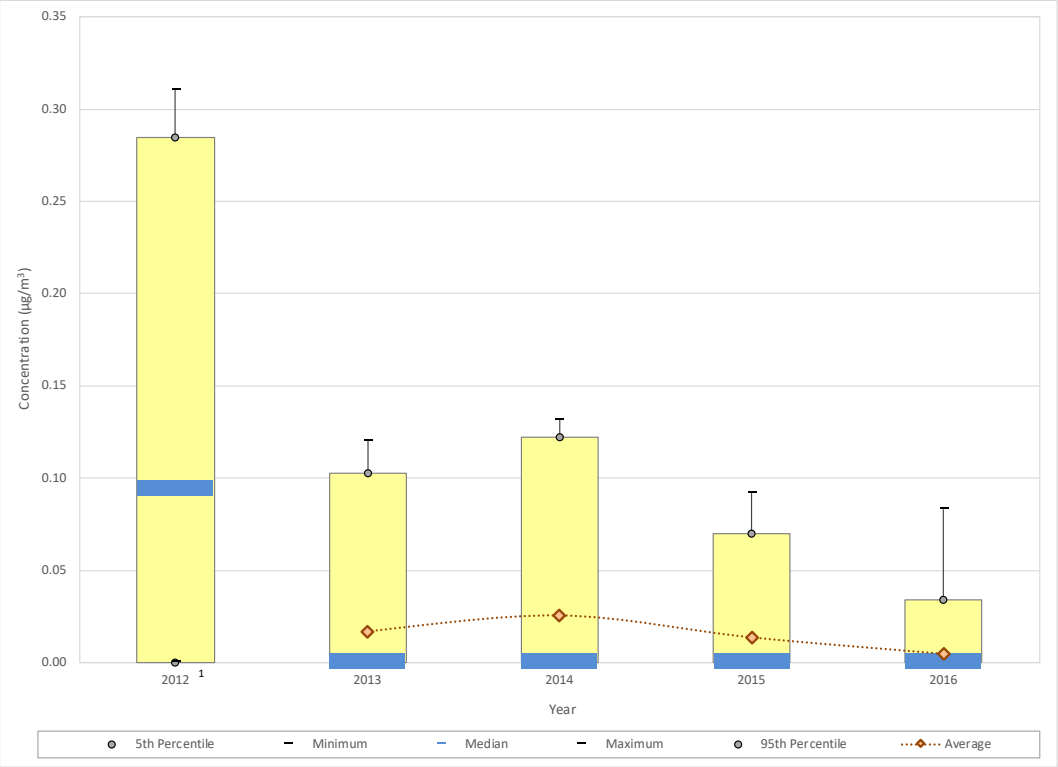
Observations from Figure 7-41 for benzene concentrations measured at RFCO include the following:

- Sampling for SNMOCs at RFCO began under the NMP in June 2012. Because a full year's worth of data is not available for 2012, a 1-year average is not presented, although the range of measurements is provided.

- With the exception of 2015, the range of benzene concentrations has not varied much across the years of sampling, with roughly 1 µg/m^3 separating the minimum and maximum concentrations measured.

- The two highest benzene concentrations measured at RFCO were measured on back-to-back sample days in March 2015 (6.62 µg/m^3 and 5.87 µg/m^3). The next highest concentration measured in 2015 is considerably less (0.74 µg/m^3). If the two highest benzene concentrations were removed from the dataset, 2015 would have the smallest range of measurements and the 1-year average concentration would decrease by half, making it the lowest 1-year average. The median, however, would change very little. In fact, the median concentrations shown in Figure 7-41 vary by only 0.11 µg/m^3.

Figure 7-42. Yearly Statistical Metrics for 1,3-Butadiene Concentrations Measured at RFCO



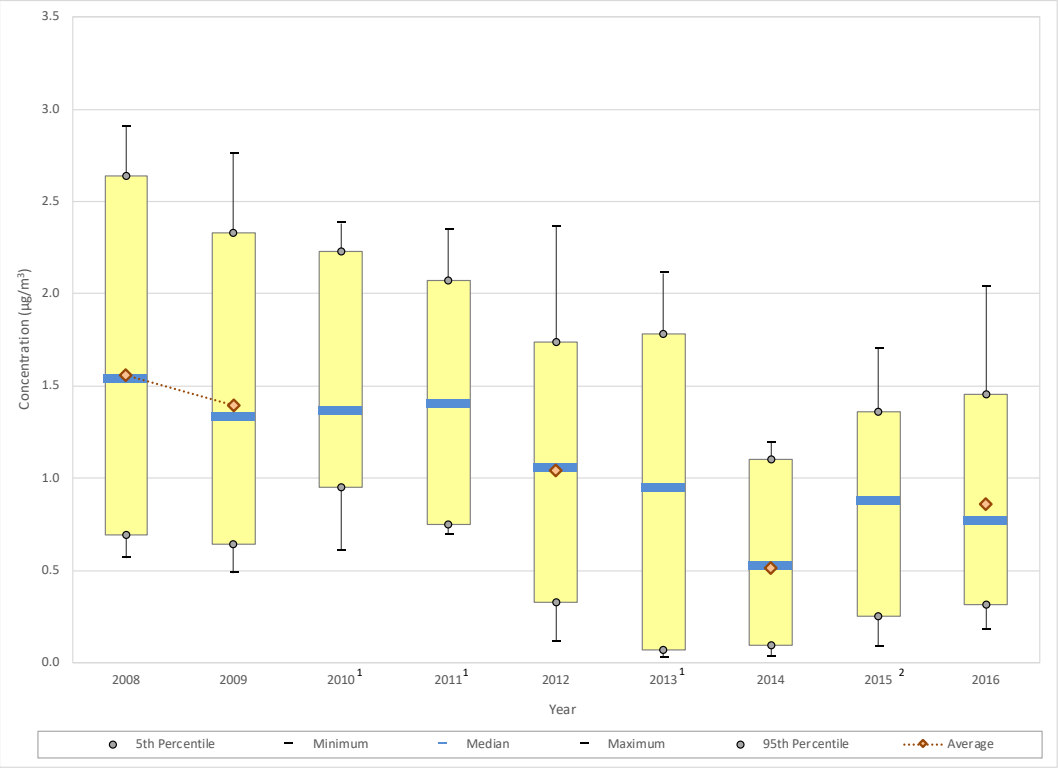
[1] A 1-year average is not presented because sampling did not begin until June 2012.

Observations from Figure 7-42 for 1,3-butadiene concentrations measured at RFCO include the following:

- The six highest 1,3-butadiene concentrations, ranging from 0.23 µg/m^3 to 0.31 µg/m^3, were measured at RFCO in 2012. Concentrations of 1,3-butadiene greater than 0.15 µg/m^3 were not measured during any other year of sampling at RFCO and concentrations greater than 0.10 µg/m^3 were not measured at RFCO in 2015 or 2016.

- The median concentration is zero for the years after 2012, indicating that at least half of the 1,3-butadiene measurements were non-detects. There were five non-detects in 2012, accounting for nearly 30 percent of the measurements (note that sampling began in June in 2012, such that the concentration profile represents seven months of sampling). For subsequent years, the detection rate decreased considerably, with non-detects accounting for between 75 percent (2014) and 93 percent (2016) of measurements.

Figure 7-43. Yearly Statistical Metrics for Acetaldehyde Concentrations Measured at RICO



[1] A 1-year average is not presented due to low method completeness in 2010, 2011, and 2013.
[2] A 1-year average is not presented for 2015 due to low method completeness combined with coelution.

Observations from Figure 7-43 for acetaldehyde concentrations measured at RICO include the following:

- RICO began sampling carbonyl compounds under the NMP in February 2008. A 1-year average concentration is not presented for 2010, 2011, or 2013 due to low method completeness; a 1-year average is not presented for 2015 due to low

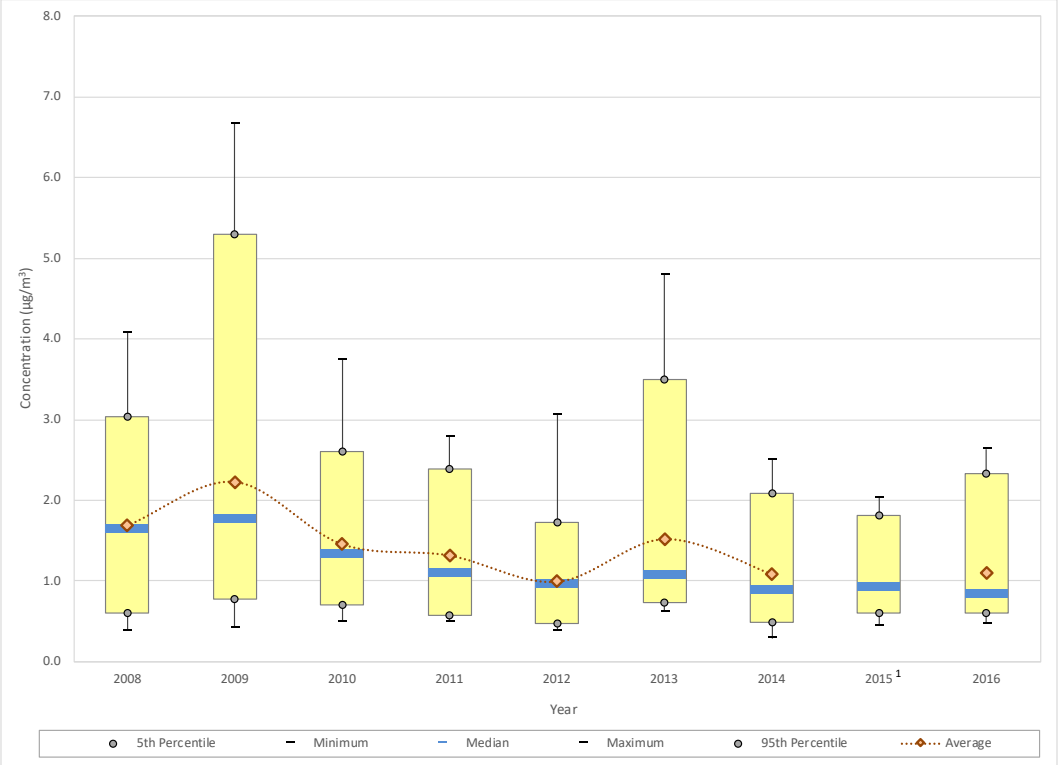
completeness combined with coelution, as indicated in Section 7.3.1. However, the range of measurements is provided for each of these years.

- The maximum acetaldehyde concentration (2.91 µg/m^3) was measured at RICO in July 2008, although a similar concentration was also measured on the sample day prior.

- Few 1-year average concentrations could be calculated for RICO. However, the measurements have a decreasing trend through 2014, based on the decreases shown for nearly all of the other statistical parameters, many of which are at a minimum for 2014.

- All of the available statistical parameters exhibit increases for 2015, and several exhibit additional increases for 2016 (the median concentration is the exception).

Figure 7-44. Yearly Statistical Metrics for Benzene Concentrations Measured at RICO



[1] A 1-year average is not presented for 2015 due to low method completeness.

Observations from Figure 7-44 for benzene concentrations measured at RICO include the following:

- RICO began sampling SNMOCs under the NMP in January 2008.

- The maximum benzene concentration (6.67 µg/m^3) was measured in January 2009. The six highest benzene concentrations measured at RICO were all measured in 2009, with the four highest measured in January.

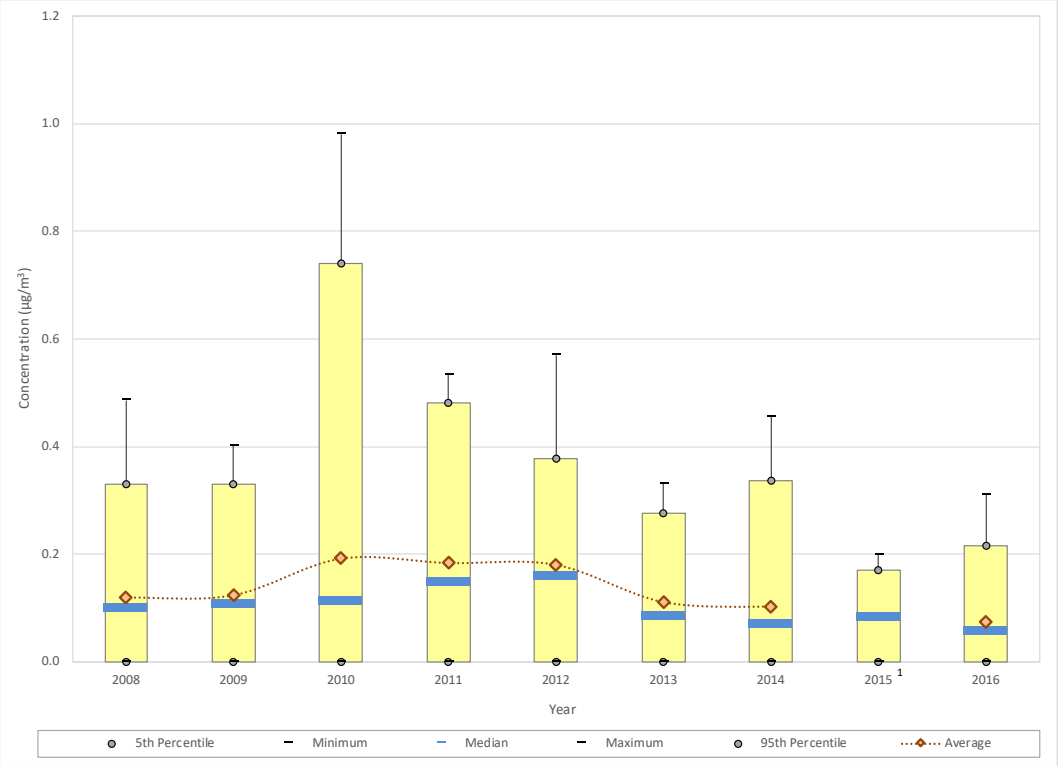
- All of the statistical parameters exhibit increases from 2008 to 2009, particularly the maximum concentration and the 95th percentile, after which a steady decreasing trend is shown through 2012. The number of measurements greater than 2 µg/m^3 increased from 19 to 25 from 2008 to 2009, then decreased by half for 2010 and continued to decrease, reaching a minimum of two for 2012. This helps explain the increase in the statistical parameters shown from 2008 to 2009 as well as the subsequent decreases in the years that follow. The median concentration is 0.96 µg/m^3 for 2012, indicating that at least half of the measurements are less than 1 µg/m^3. The 1-year average concentration is also less than 1 µg/m^3 for 2012.

- All of the statistical parameters exhibit increases for 2013 as benzene concentrations were higher overall in 2013. The number of concentrations greater than 2 µg/m^3 increased six-fold from 2012 (2) to 2013 (13). Five concentrations measured in 2013 are greater than the maximum concentration measured in 2012, while 11 concentrations measured in 2012 are less than the minimum concentration measured in 2013.

- The increases shown for 2013 were followed by significant decreases for 2014, although not quite returning to 2012 levels. The statistical parameters shown for RICO's benzene concentrations resemble the ones shown for benzene concentrations measured at PACO (and to a lesser extent BRCO), as all three sites exhibit a decreasing trend through 2012 followed by a considerable increase for 2013 and additional decreases for 2014.

- The smallest range of benzene concentrations was measured in 2015. The range of measurements increases for 2016, such that the concentration profile for 2016 is similar to that shown for 2014.

Figure 7-45. Yearly Statistical Metrics for 1,3-Butadiene Concentrations Measured at RICO



[1] A 1-year average is not presented for 2015 due to low method completeness.

Observations from Figure 7-45 for 1,3-butadiene concentrations measured at RICO include the following:

- The five highest 1,3-butadiene concentrations were measured at RICO in December 2010 and ranged from 0.57 µg/m^3 to 0.98 µg/m^3 (although a measurement of 0.57 µg/m^3 was also measured in 2012). Higher 1,3-butadiene concentrations were also measured at PACO during December 2010.

- The minimum concentration and 5th percentile are both zero for each year of sampling; this indicates that at least 5 percent of the measurements were non-detects each year. The percentage of non-detects has varied from 7 percent (2012) to 39 percent (2014).

- With the exception of the maximum concentration, the range of concentrations measured in 2008 and 2009 were similar to each other, as indicated by most of the statistical parameters shown. This was followed by an increase in the magnitude of the concentrations measured in 2010. Even though the maximum concentration and 95th percentile more than doubled and the 1-year average concentration increased by more than 50 percent, the median concentration changed very little for 2010. This indicates that there are roughly the same number of measurements at the lower end of the concentration range while the measurements at the higher end of the concentration range are driving the 1-year average concentration upward.

- Although the range of concentrations measured varies between 2010 and 2012, the 1-year average concentration decreases slightly while the median concentration increases slightly.

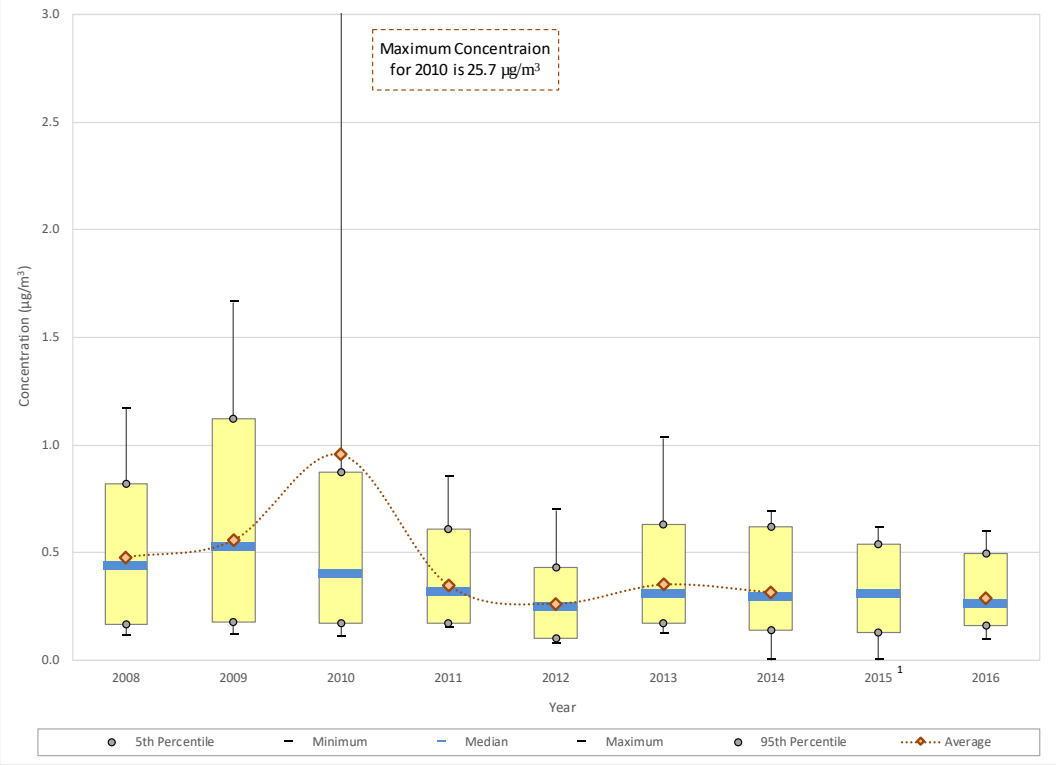
- Most of the statistical parameters exhibit decreases from 2012 to 2013 (the minimum and 5th percentile both stay the same), with the median concentration decreasing by almost half. This indicates that the 1,3-butadiene concentrations measured were lower in 2013.

- Although little change is shown in the 1-year average concentration for 2014, five concentrations measured in 2014 are greater than the maximum concentration measured in 2013. On the lower end of the scale, the number of non-detects increased four-fold, from five measured in 2013 to 21 measured in 2014.

- The smallest range of 1,3-butadiene concentrations was measured in 2015; all 1,3-butadiene concentrations measured at RICO in 2015 are less than 0.2 µg/m^3.

- Despite the slightly larger range of concentrations measured, the central tendency statistics are both at minimum for 2016.

Figure 7-46. Yearly Statistical Metrics for Ethylbenzene Concentrations Measured at RICO



[1] A 1-year average is not presented for 2015 due to low method completeness.

Observations from Figure 7-46 for ethylbenzene concentrations measured at RICO include the following:

- The maximum ethylbenzene concentration measured at RICO was measured on August 18, 2010 (25.7 µg/m^3). The next highest concentration was also measured in 2010 but is considerably less (6.86 µg/m^3). No other ethylbenzene concentrations greater than 2 µg/m^3 have been measured at RICO and only nine concentrations greater than 1 µg/m^3 have been measured at this site. This explains why the 1-year average concentration is greater than the 95th percentile for 2010, it is skewed by the outlier. Excluding the maximum concentration from the 1-year average calculation for 2010 would result in a 1-year average concentration similar to that shown for 2009.

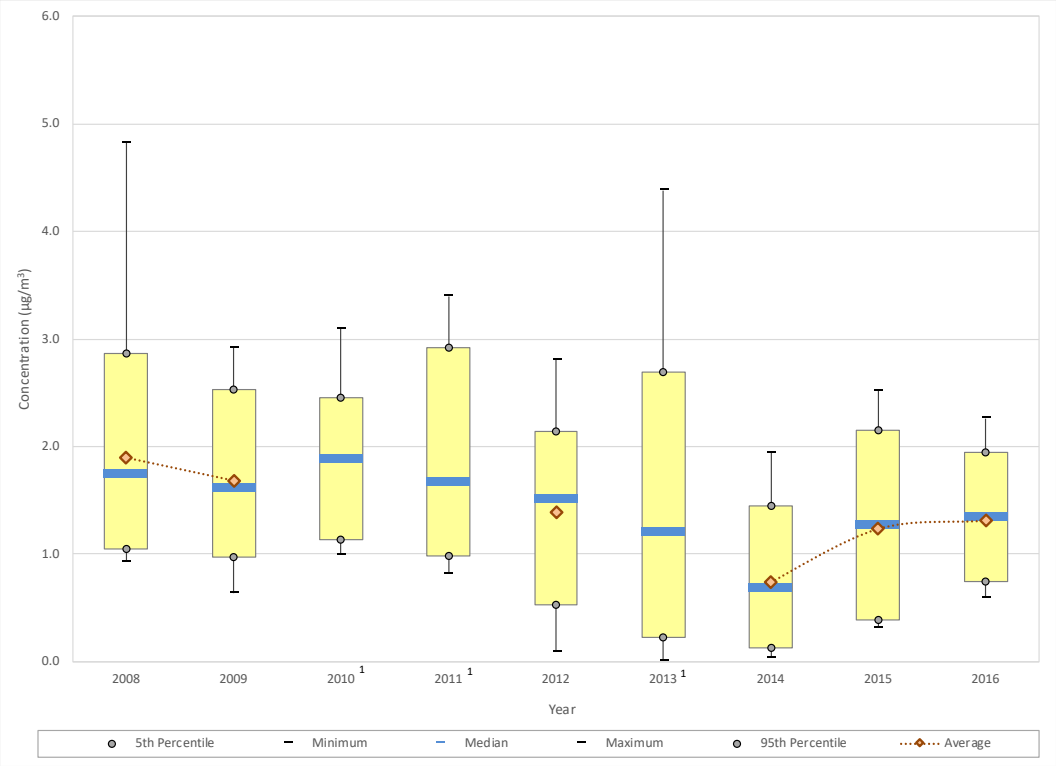
- Excluding the outlier, there is a decreasing trend in most of the statistical parameters shown between 2009 and 2012, with most of the statistical parameters at a minimum for 2012.

- Each of the statistical parameters shown in Figure 7-46 increased from 2012 to 2013, with several of them returning to levels similar to those calculated for 2011.

- The range of ethylbenzene concentrations measured decreases slightly each year between 2013 and 2016, with only slight changes in the 1-year average and median concentrations.

- Three non-detects of ethylbenzene have been measured at RICO, two in 2014 and another in 2015.

Figure 7-47. Yearly Statistical Metrics for Formaldehyde Concentrations Measured at RICO



[1] A 1-year average is not presented due to low method completeness in 2010, 2011, and 2013.

Observations from Figure 7-47 for formaldehyde concentrations measured at RICO include the following:

- The maximum formaldehyde concentration (4.82 µg/m^3) was measured at RICO in November 2008. The only other formaldehyde concentration greater than 4 µg/m^3 was measured in August 2013 (4.38 µg/m^3). Three additional formaldehyde concentrations measured at RICO are greater than 3 µg/m^3 (one each in 2008, 2010, and 2011).

- Formaldehyde concentrations measured at RICO have an overall decreasing trend between 2010 and 2014, despite a few higher concentrations measured, based on the decreases shown for several of the other statistical parameters. The median concentration decreases by 64 percent during this time, from 1.88 µg/m^3 in 2010 to 0.68 µg/m^3 for 2014. All of the statistical parameters except the minimum concentration are at a minimum for 2014.

- A 1-year average concentration is available for each year from 2014 through 2016. A significant increase in this parameter is shown from 2014 to 2015, with a slight increase for 2016. The median concentration has a similar pattern. The 1-year average and median concentrations for 2015 and 2016 are just slightly less than the 95th percentile for 2014. This results from changes at both the upper and lower ends of the concentration range. The number of formaldehyde concentrations greater than 1 µg/m^3 nearly tripled between 2014 (8) and 2016 (22) while the number of

formaldehyde concentrations less than 0.5 µg/m^3 decreased from seven (2014) to none (2016).

7.4 Additional Risk-Based Screening Evaluations

The following risk-based screening evaluations were conducted to characterize risk related to the air toxics measured at each Colorado monitoring site. Refer to Sections 3.2, 3.4.2.3, and 3.4.2.4 for definitions and explanations regarding the various toxicity factors, time frames, and calculations associated with these risk-based screenings.

7.4.1 Cancer Risk and Noncancer Hazard Approximations

For the pollutants of interest for the Colorado monitoring sites, risk was examined by calculating cancer risk and noncancer hazard approximations for each year annual average concentrations could be calculated. These approximations can be used as risk estimates for cancer and noncancer effects attributable to the pollutants of interest. Although the use of these approximations is limited, they may help identify where policy-makers want to shift their air monitoring priorities. Refer to Section 3.4.2.3 for an explanation of how cancer risk and noncancer hazard approximations are calculated and what limitations are associated with them. Annual averages, cancer UREs and/or noncancer RfCs, and cancer risk and noncancer hazard approximations are presented in Table 7-4, where applicable. Cancer risk approximations are presented as probabilities while the noncancer hazard approximations are ratios and thus, unitless values.

Observations for GPCO from Table 7-4 include the following:

- Dichloromethane (2016 only), formaldehyde, and acetaldehyde have the highest annual average concentrations among GPCO's pollutants of interest.

- Formaldehyde has the highest cancer risk approximations for this site (41.07 in-a-million for 2015 and 36.35 in-a-million for 2015). The remaining cancer risk approximations, where they could be calculated, are all less than 10 in-a-million, with several less than 1 in-a-million.

- None of the pollutants of interest for GPCO have noncancer hazard approximations greater than 1.0, indicating that no adverse noncancer health effects are expected from these individual pollutants. Acetaldehyde and formaldehyde have the highest noncancer hazard approximations (the only ones greater than an HQ of 0.10) among the pollutants of interest for GPCO.

Table 7-4. Risk Approximations for the Colorado Monitoring Sites

Pollutant	Cancer URE ($\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	2015				2016			
			# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Risk Approximations		# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Risk Approximations	
					Cancer (in-a-million)	Noncancer (HQ)			Cancer (in-a-million)	Noncancer (HQ)
Grand Junction, Colorado - GPCO										
Acetaldehyde	0.0000022	0.009	55/55	1.63 ± 0.17	3.58	0.18	59/59	1.81 ± 0.15	3.97	0.20
Benzene	0.0000078	0.03	50/50	NA	NA	NA	62/62	0.71 ± 0.09	5.56	0.02
1,3-Butadiene	0.00003	0.002	50/50	NA	NA	NA	62/62	0.11 ± 0.02	3.31	0.06
Carbon Tetrachloride	0.000006	0.1	50/50	NA	NA	NA	62/62	0.60 ± 0.03	3.60	0.01
1,2-Dichloroethane	0.000026	2.4	47/50	NA	NA	NA	52/62	0.07 ± 0.01	1.78	<0.01
Dichloromethane	0.000000016	0.6	50/50	NA	NA	NA	62/62	4.19 ± 4.52	0.07	0.01
Ethylbenzene	0.0000025	1	50/50	NA	NA	NA	62/62	0.30 ± 0.04	0.76	<0.01
Formaldehyde	0.000013	0.0098	55/55	3.16 ± 0.51	41.07	0.32	59/59	2.80 ± 0.18	36.35	0.29
Acenaphthene[a]	0.000088	--	55/55	8.29 ± 3.97	0.73	--	58/61	5.67 ± 1.20	0.50	--
Arsenic (PM_{10})[a]	0.0043	0.000015	57/57	0.28 ± 0.03	1.19	0.02	60/60	0.32 ± 0.06	1.36	0.02
Fluoranthene[a]	0.000088	--	55/55	5.59 ± 2.16	0.49	--	61/61	4.13 ± 1.09	0.36	--
Naphthalene[a]	0.000034	0.003	55/55	91.01 ± 12.89	3.09	0.03	61/61	74.38 ± 9.54	2.53	0.02

-- = A Cancer URE or Noncancer RfC is not available.
NA = Not available because the criteria for calculating an annual average were not met.
NS = Sampling was not conducted during this time.
[a] Average concentrations provided for the pollutants below the blue line for GPCO are presented in ng/m^3 for ease of viewing.

Table 7-4. Risk Approximations for the Colorado Monitoring Sites (Continued)

Pollutant	Cancer URE ($\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	2015				2016			
			# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Risk Approximations		# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Risk Approximations	
					Cancer (in-a-million)	Noncancer (HQ)			Cancer (in-a-million)	Noncancer (HQ)
Battlement Mesa, Colorado - BMCO										
Acetaldehyde	0.0000022	0.009	3/3	NA	NA	NA	24/24	0.48 ± 0.10	1.05	0.05
Benzene	0.0000078	0.03	6/6	NA	NA	NA	48/48	0.79 ± 0.06	6.17	0.03
Formaldehyde	0.000013	0.0098	3/3	NA	NA	NA	24/24	0.93 ± 0.18	12.10	0.09
Silt, Colorado - BRCO										
Acetaldehyde	0.0000022	0.009	28/28	0.51 ± 0.11	1.12	0.06	26/26	0.22 ± 0.08	0.49	0.02
Benzene	0.0000078	0.03	52/52	0.66 ± 0.12	5.16	0.02	57/58	0.71 ± 0.11	5.51	0.02
Formaldehyde	0.000013	0.0098	28/28	0.82 ± 0.17	10.71	0.08	26/26	0.37 ± 0.14	4.81	0.04
Glenwood Springs, Colorado - GSCO										
Acetaldehyde	0.0000022	0.009	26/26	0.53 ± 0.10	1.16	0.06	5/5	NS	NS	NS
Benzene	0.0000078	0.03	52/52	0.49 ± 0.04	3.85	0.02	12/12	NS	NS	NS
1,3-Butadiene	0.00003	0.002	19/52	0.02 ± 0.01	0.63	0.01	8/12	NS	NS	NS
Formaldehyde	0.000013	0.0098	26/26	0.80 ± 0.14	10.42	0.08	5/5	NS	NS	NS

-- = A Cancer URE or Noncancer RfC is not available.
NA = Not available because the criteria for calculating an annual average were not met.
NS = Sampling was not conducted during this time.
[a] Average concentrations provided for the pollutants below the blue line for GPCO are presented in ng/m^3 for ease of viewing.

Table 7-4. Risk Approximations for the Colorado Monitoring Sites (Continued)

Pollutant	Cancer URE ($\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	2015				2016			
			# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Risk Approximations		# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Risk Approximations	
					Cancer (in-a-million)	Noncancer (HQ)			Cancer (in-a-million)	Noncancer (HQ)
Parachute, Colorado - PACO										
Acetaldehyde	0.0000022	0.009	17/18	NA	NA	NA	29/29	0.59 ± 0.11	1.29	0.07
Benzene	0.0000078	0.03	54/54	1.21 ± 0.16	9.46	0.04	54/54	1.20 ± 0.14	9.39	0.04
1,3-Butadiene	0.00003	0.002	7/54	0.01 ± 0.01	0.24	<0.01	2/54	<0.00 ± <0.00	0.06	<0.01
Formaldehyde	0.000013	0.0098	18/18	NA	NA	NA	29/29	1.18 ± 0.19	15.32	0.12
Carbondale, Colorado - RFCO										
Benzene	0.0000078	0.03	24/26	0.92 ± 0.68	7.18	0.03	27/27	0.45 ± 0.08	3.52	0.02
1,3-Butadiene	0.00003	0.002	5/26	0.01 ± 0.01	0.41	0.01	2/27	<0.01 ± 0.01	0.15	<0.01
Carbon Tetrachloride	0.000006	0.1	20/20	NA	NA	NA	NA	NA	NA	NA
1,2-Dichloroethane	0.000026	2.4	19/20	NA	NA	NA	NA	NA	NA	NA

-- = A Cancer URE or Noncancer RfC is not available.
NA = Not available due to the criteria for calculating an annual average.
NS = Sampling was not conducted during this time.
[a] Average concentrations provided for the pollutants below the blue line for GPCO are presented in ng/m^3 for ease of viewing.

Table 7-4. Risk Approximations for the Colorado Monitoring Sites (Continued)

Pollutant	Cancer URE ($\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	2015				2016			
			# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Risk Approximations		# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Risk Approximations	
					Cancer (in-a-million)	Noncancer (HQ)			Cancer (in-a-million)	Noncancer (HQ)
Rifle, Colorado - RICO										
Acetaldehyde	0.0000022	0.009	25/26	NA	NA	NA	30/30	0.86 ± 0.15	1.89	0.10
Benzene	0.0000078	0.03	44/46	NA	NA	NA	62/62	1.10 ± 0.14	8.56	0.04
1,3-Butadiene	0.00003	0.002	38/46	NA	NA	NA	39/62	0.07 ± 0.02	2.23	0.04
Ethylbenzene	0.0000025	1	45/46	NA	NA	NA	62/62	0.29 ± 0.03	0.72	<0.01
Formaldehyde	0.000013	0.0098	26/26	1.24 ± 0.21	16.06	0.13	30/30	1.31 ± 0.16	17.04	0.13

-- = A Cancer URE or Noncancer RfC is not available.
NA = Not available due to the criteria for calculating an annual average.
NS = Sampling was not conducted during this time.
[a] Average concentrations provided for the pollutants below the blue line for GPCO are presented in ng/m^3 for ease of viewing.

Observations for the Garfield County sites from Table 7-4 include the following:

- Benzene, acetaldehyde, and formaldehyde were identified as pollutants of interest for most of the Garfield County sites. RICO and PACO have the highest annual average concentrations of these pollutants among the Garfield County sites (where they could be calculated).

- The cancer risk approximations for formaldehyde for these sites range from 4.81 in-a-million (BRCO, 2016) to 17.04 in-a-million (RICO, 2016). The noncancer hazard approximations calculated for formaldehyde for the Garfield County sites with available annual average concentrations are considerably less than 1.0 (all are less than an HQ of 0.15). This indicates that no adverse noncancer health effects are expected from this individual pollutant.

- The cancer risk approximations for acetaldehyde for these sites range from 0.49 in-a-million (BRCO, 2016) to 1.89 in-a-million (RICO, 2016). The noncancer hazard approximations calculated for acetaldehyde for the Garfield County sites with available annual average concentrations are considerably less than 1.0 (all are 0.10 or less). This indicates that no adverse noncancer health effects are expected from this individual pollutant.

- Cancer risk approximations for benzene for these sites range from 3.52 in-a-million (RFCO, 2016) to 9.46 in-a-million (PACO, 2015). The noncancer hazard approximations calculated for benzene for the Garfield County sites with available annual average concentrations are considerably less than 1.0 (all are less than or equal to an HQ of 0.04). This indicates that no adverse noncancer health effects are expected from this individual pollutant.

- 1,3-Butadiene was identified as a pollutant of interest for GSCO, PACO, RFCO, and RICO. The cancer risk approximations for these sites for 1,3-butadiene range from 0.06 in-a-million (PACO, 2016) to 2.23 in-a-million (RICO, 2016). The noncancer hazard approximations calculated for 1,3-butadiene for these Garfield County sites are less than 0.05.

7.4.2 Risk-Based Emissions Assessment

In addition to the risk-based screening discussed above, this section presents an evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 7-5 presents the 10 pollutants with the highest emissions from the 2014 NEI (version 1) that have cancer toxicity factors. Table 7-5 also presents the 10 pollutants with the highest toxicity-weighted emissions, based on the weighting schema described in Section 3.4.2.4. Lastly, Table 7-5 provides the pollutants of interest with the highest cancer risk approximations (in-a-million) for each site, as presented in Table 7-4. Cancer risk approximations for 2015 are presented in green while approximations for 2016 are in white. The emissions, toxicity-weighted emissions, and cancer risk approximations are shown in descending order in Table 7-5. Table 7-6 presents similar information, but is limited to those pollutants with noncancer toxicity factors.

Because not all pollutants have both cancer and noncancer toxicity factors, the highest emitted pollutants in the cancer table may be different from the noncancer table, although the actual quantity of emissions is the same. The cancer risk and noncancer hazard approximations based on each site's annual averages are limited to the pollutants of interest identified for each site. In addition, the cancer risk and noncancer hazard approximations are limited to those pollutants with enough data to meet the criteria for annual averages to be calculated. A more in-depth discussion of this analysis is provided in Section 3.4.2.4. Similar to the cancer risk and noncancer hazard approximations provided in Section 7.4.1, this analysis may help policy-makers prioritize their air monitoring activities.

Table 7-5. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Colorado Monitoring Sites

Top 10 Total Emissions for Pollutants with Cancer UREs (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Annual Average Concentrations (Site-Specific) [1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Grand Junction, Colorado (Mesa County) - GPCO					
Benzene	124.55	Formaldehyde	1.34E-03	Formaldehyde	41.07
Formaldehyde	103.42	Benzene	9.72E-04	Formaldehyde	36.35
Acetaldehyde	39.94	Ethylene oxide	3.25E-04	Benzene	5.56
Ethylbenzene	34.04	1,3-Butadiene	2.88E-04	Acetaldehyde	3.97
1,3-Butadiene	9.59	Naphthalene	2.34E-04	Carbon Tetrachloride	3.60
Naphthalene	6.87	POM, Group 2b	9.59E-05	Acetaldehyde	3.58
Bis(2-ethylhexyl) phthalate, gas	6.86	Acetaldehyde	8.79E-05	1,3-Butadiene	3.31
POM, Group 2b	1.09	Ethylbenzene	8.51E-05	Naphthalene	3.09
POM, Group 2d	0.82	POM, Group 2d	7.19E-05	Naphthalene	2.53
2,4-Toluene diisocyanate	0.59	POM, Group 5a	5.46E-05	1,2-Dichloroethane	1.78
Battlement Mesa, Colorado (Garfield County) - BMCO					
Benzene	831.13	Formaldehyde	9.09E-03	Formaldehyde	12.10
Formaldehyde	699.31	Benzene	6.48E-03	Benzene	6.17
Acetaldehyde	141.90	1,3-Butadiene	4.07E-04	Acetaldehyde	1.05
Ethylbenzene	64.35	Acetaldehyde	3.12E-04		
1,3-Butadiene	13.58	Naphthalene	1.84E-04		
Naphthalene	5.41	Ethylbenzene	1.61E-04		
Bis(2-ethylhexyl) phthalate, gas	2.65	1,2-Dibromoethane	1.26E-04		
POM, Group 1a	1.07	POM, Group 1a	9.43E-05		
Dichloromethane	0.62	POM, Group 2b	5.41E-05		
POM, Group 2b	0.62	POM, Group 2d	4.36E-05		

[1]Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Table 7-5. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Colorado Monitoring Sites (Continued)

Top 10 Total Emissions for Pollutants with Cancer UREs (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Annual Average Concentrations (Site-Specific) [1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Silt, Colorado (Garfield County) - BRCO					
Benzene	831.13	Formaldehyde	9.09E-03	Formaldehyde	10.71
Formaldehyde	699.31	Benzene	6.48E-03	Benzene	5.51
Acetaldehyde	141.90	1,3-Butadiene	4.07E-04	Benzene	5.16
Ethylbenzene	64.35	Acetaldehyde	3.12E-04	Formaldehyde	4.81
1,3-Butadiene	13.58	Naphthalene	1.84E-04	Acetaldehyde	1.12
Naphthalene	5.41	Ethylbenzene	1.61E-04	Acetaldehyde	0.49
Bis(2-ethylhexyl) phthalate, gas	2.65	1,2-Dibromoethane	1.26E-04		
POM, Group 1a	1.07	POM, Group 1a	9.43E-05		
Dichloromethane	0.62	POM, Group 2b	5.41E-05		
POM, Group 2b	0.62	POM, Group 2d	4.36E-05		
Glenwood Springs, Colorado (Garfield County) - GSCO					
Benzene	831.13	Formaldehyde	9.09E-03	Formaldehyde	10.42
Formaldehyde	699.31	Benzene	6.48E-03	Benzene	3.85
Acetaldehyde	141.90	1,3-Butadiene	4.07E-04	Acetaldehyde	1.16
Ethylbenzene	64.35	Acetaldehyde	3.12E-04	1,3-Butadiene	0.63
1,3-Butadiene	13.58	Naphthalene	1.84E-04		
Naphthalene	5.41	Ethylbenzene	1.61E-04		
Bis(2-ethylhexyl) phthalate, gas	2.65	1,2-Dibromoethane	1.26E-04		
POM, Group 1a	1.07	POM, Group 1a	9.43E-05		
Dichloromethane	0.62	POM, Group 2b	5.41E-05		
POM, Group 2b	0.62	POM, Group 2d	4.36E-05		

[1]Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Table 7-5. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Colorado Monitoring Sites (Continued)

Top 10 Total Emissions for Pollutants with Cancer UREs (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Annual Average Concentrations (Site-Specific) [1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Parachute, Colorado (Garfield County) - PACO					
Benzene	831.13	Formaldehyde	9.09E-03	Formaldehyde	15.32
Formaldehyde	699.31	Benzene	6.48E-03	Benzene	9.46
Acetaldehyde	141.90	1,3-Butadiene	4.07E-04	Benzene	9.39
Ethylbenzene	64.35	Acetaldehyde	3.12E-04	Acetaldehyde	1.29
1,3-Butadiene	13.58	Naphthalene	1.84E-04	1,3-Butadiene	0.24
Naphthalene	5.41	Ethylbenzene	1.61E-04	1,3-Butadiene	0.06
Bis(2-ethylhexyl) phthalate, gas	2.65	1,2-Dibromoethane	1.26E-04		
POM, Group 1a	1.07	POM, Group 1a	9.43E-05		
Dichloromethane	0.62	POM, Group 2b	5.41E-05		
POM, Group 2b	0.62	POM, Group 2d	4.36E-05		
Carbondale, Colorado (Garfield County) - RFCO					
Benzene	831.13	Formaldehyde	9.09E-03	Benzene	7.18
Formaldehyde	699.31	Benzene	6.48E-03	Benzene	3.52
Acetaldehyde	141.90	1,3-Butadiene	4.07E-04	1,3-Butadiene	0.41
Ethylbenzene	64.35	Acetaldehyde	3.12E-04	1,3-Butadiene	0.15
1,3-Butadiene	13.58	Naphthalene	1.84E-04		
Naphthalene	5.41	Ethylbenzene	1.61E-04		
Bis(2-ethylhexyl) phthalate, gas	2.65	1,2-Dibromoethane	1.26E-04		
POM, Group 1a	1.07	POM, Group 1a	9.43E-05		
Dichloromethane	0.62	POM, Group 2b	5.41E-05		
POM, Group 2b	0.62	POM, Group 2d	4.36E-05		

[1]Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Table 7-5. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Colorado Monitoring Sites (Continued)

Top 10 Total Emissions for Pollutants with Cancer UREs (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Annual Average Concentrations (Site-Specific) [1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Rifle, Colorado (Garfield County) - RICO					
Benzene	831.13	Formaldehyde	9.09E-03	Formaldehyde	17.04
Formaldehyde	699.31	Benzene	6.48E-03	Formaldehyde	16.06
Acetaldehyde	141.90	1,3-Butadiene	4.07E-04	Benzene	8.56
Ethylbenzene	64.35	Acetaldehyde	3.12E-04	1,3-Butadiene	2.23
1,3-Butadiene	13.58	Naphthalene	1.84E-04	Acetaldehyde	1.89
Naphthalene	5.41	Ethylbenzene	1.61E-04	Ethylbenzene	0.72
Bis(2-ethylhexyl) phthalate, gas	2.65	1,2-Dibromoethane	1.26E-04		
POM, Group 1a	1.07	POM, Group 1a	9.43E-05		
Dichloromethane	0.62	POM, Group 2b	5.41E-05		
POM, Group 2b	0.62	POM, Group 2d	4.36E-05		

[1]Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Table 7-6. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the Colorado Monitoring Sites

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific) [1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Hazard Approximation (HQ)**
Grand Junction, Colorado (Mesa County) - GPCO					
Toluene	245.90	Acrolein	521,714.21	Formaldehyde	0.32
Xylenes	209.88	Formaldehyde	10,553.12	Formaldehyde	0.29
Benzene	124.55	2,4-Toluene diisocyanate	8,393.50	Acetaldehyde	0.20
Formaldehyde	103.42	1,3-Butadiene	4,793.06	Acetaldehyde	0.18
Methanol	75.05	Acetaldehyde	4,437.71	1,3-Butadiene	0.06
Hexane	56.39	Benzene	4,151.73	Naphthalene	0.03
Acetaldehyde	39.94	Naphthalene	2,289.23	Naphthalene	0.02
Ethylbenzene	34.04	Xylenes	2,098.80	Benzene	0.02
Styrene	11.62	Lead, PM	1,291.29	Arsenic	0.02
Acrolein	10.43	Antimony, PM	1,051.02	Arsenic	0.02
Battlement Mesa, Colorado (Garfield County) - BMCO					
Xylenes	1,453.50	Acrolein	3,865,686.15	Formaldehyde	0.09
Benzene	831.13	Formaldehyde	71,358.40	Acetaldehyde	0.05
Toluene	751.51	Benzene	27,704.24	Benzene	0.03
Formaldehyde	699.31	Acetaldehyde	15,766.16		
Methanol	495.03	Xylenes	14,534.96		
Hexane	159.66	1,3-Butadiene	6,788.90		
Acetaldehyde	141.90	2,4-Toluene diisocyanate	3,245.03		
Acrolein	77.31	Naphthalene	1,802.56		
Ethylbenzene	64.35	Cadmium, PM	761.59		
1,3-Butadiene	13.58	Lead, PM	570.68		

[1]Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Table 7-6. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the Colorado Monitoring Sites (Continued)

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific) [1]	
Pollutant	Emissions (tpy)	Pollutant	Noncancer Toxicity Weight	Pollutant	Noncancer Hazard Approximation (HQ)
Silt, Colorado (Garfield County) - BRCO					
Xylenes	1,453.50	Acrolein	3,865,686.15	Formaldehyde	0.08
Benzene	831.13	Formaldehyde	71,358.40	Acetaldehyde	0.06
Toluene	751.51	Benzene	27,704.24	Formaldehyde	0.04
Formaldehyde	699.31	Acetaldehyde	15,766.16	Acetaldehyde	0.02
Methanol	495.03	Xylenes	14,534.96	Benzene	0.02
Hexane	159.66	1,3-Butadiene	6,788.90	Benzene	0.02
Acetaldehyde	141.90	2,4-Toluene diisocyanate	3,245.03		
Acrolein	77.31	Naphthalene	1,802.56		
Ethylbenzene	64.35	Cadmium, PM	761.59		
1,3-Butadiene	13.58	Lead, PM	570.68		
Glenwood Springs, Colorado (Garfield County) - GSCO					
Xylenes	1,453.50	Acrolein	3,865,686.15	Formaldehyde	0.08
Benzene	831.13	Formaldehyde	71,358.40	Acetaldehyde	0.06
Toluene	751.51	Benzene	27,704.24	Benzene	0.02
Formaldehyde	699.31	Acetaldehyde	15,766.16	1,3-Butadiene	0.01
Methanol	495.03	Xylenes	14,534.96		
Hexane	159.66	1,3-Butadiene	6,788.90		
Acetaldehyde	141.90	2,4-Toluene diisocyanate	3,245.03		
Acrolein	77.31	Naphthalene	1,802.56		
Ethylbenzene	64.35	Cadmium, PM	761.59		
1,3-Butadiene	13.58	Lead, PM	570.68		

[1]Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Table 7-6. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the Colorado Monitoring Sites (Continued)

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific) [1]	
Pollutant	Emissions (tpy)	Pollutant	Noncancer Toxicity Weight	Pollutant	Noncancer Hazard Approximation (HQ)
Parachute, Colorado (Garfield County) - PACO					
Xylenes	1,453.50	Acrolein	3,865,686.15	Formaldehyde	0.12
Benzene	831.13	Formaldehyde	71,358.40	Acetaldehyde	0.07
Toluene	751.51	Benzene	27,704.24	Benzene	0.04
Formaldehyde	699.31	Acetaldehyde	15,766.16	Benzene	0.04
Methanol	495.03	Xylenes	14,534.96	1,3-Butadiene	<0.01
Hexane	159.66	1,3-Butadiene	6,788.90	1,3-Butadiene	<0.01
Acetaldehyde	141.90	2,4-Toluene diisocyanate	3,245.03		
Acrolein	77.31	Naphthalene	1,802.56		
Ethylbenzene	64.35	Cadmium, PM	761.59		
1,3-Butadiene	13.58	Lead, PM	570.68		
Carbondale, Colorado (Garfield County) - RFCO					
Xylenes	1,453.50	Acrolein	3,865,686.15	Benzene	0.03
Benzene	831.13	Formaldehyde	71,358.40	Benzene	0.02
Toluene	751.51	Benzene	27,704.24	1,3-Butadiene	0.01
Formaldehyde	699.31	Acetaldehyde	15,766.16	1,3-Butadiene	<0.01
Methanol	495.03	Xylenes	14,534.96		
Hexane	159.66	1,3-Butadiene	6,788.90		
Acetaldehyde	141.90	2,4-Toluene diisocyanate	3,245.03		
Acrolein	77.31	Naphthalene	1,802.56		
Ethylbenzene	64.35	Cadmium, PM	761.59		
1,3-Butadiene	13.58	Lead, PM	570.68		

[1]Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Table 7-6. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the Colorado Monitoring Sites (Continued)

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific) [1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Hazard Approximation (HQ)**
Rifle, Colorado (Garfield County) - RICO					
Xylenes	1,453.50	Acrolein	3,865,686.15	Formaldehyde	0.13
Benzene	831.13	Formaldehyde	71,358.40	Formaldehyde	0.13
Toluene	751.51	Benzene	27,704.24	Acetaldehyde	0.10
Formaldehyde	699.31	Acetaldehyde	15,766.16	1,3-Butadiene	0.04
Methanol	495.03	Xylenes	14,534.96	Benzene	0.04
Hexane	159.66	1,3-Butadiene	6,788.90	Ethylbenzene	<0.01
Acetaldehyde	141.90	2,4-Toluene diisocyanate	3,245.03		
Acrolein	77.31	Naphthalene	1,802.56		
Ethylbenzene	64.35	Cadmium, PM	761.59		
1,3-Butadiene	13.58	Lead, PM	570.68		

[1]Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Observations from Table 7-5 include the following:

- The five highest emitted pollutants with cancer UREs in Mesa County are also the five highest emitted pollutants in Garfield County, although the emissions are higher in Garfield County. In total, there are eight pollutants in common for Garfield County and Mesa County.

- The two pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) are formaldehyde and benzene for both Mesa and Garfield Counties. These two counties have eight pollutants in common among the pollutants with the highest toxicity-weighted emissions.

- Eight of the highest emitted pollutants also have the highest toxicity-weighted emissions for Mesa County; eight pollutants have the highest emitted pollutants and highest toxicity-weighted emissions for Garfield County.

- Formaldehyde has the highest cancer risk approximations for GPCO, followed by benzene (2016 only). Formaldehyde and benzene appear at the top of all three lists in Table 7-5. Acetaldehyde, 1,3-butadiene, and naphthalene also appear on all three lists.

- Each of the pollutants of interest identified for the Garfield County sites also appear on both emissions-based lists for Garfield County in Table 7-5.

Observations from Table 7-6 include the following:

- Toluene, xylenes, and benzene are the highest emitted pollutants with a noncancer RfC in Mesa County; these same pollutants are also the highest emitted in Garfield County, although the order is different. Note that the emissions of these pollutants, particularly for xylenes, are considerably higher in Garfield County. These two counties have an additional six pollutants in common on their lists of highest emitted pollutants with noncancer RfCs.

- The pollutant with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) for both counties is acrolein. Although acrolein was sampled for at GPCO, this pollutant was excluded from the pollutants of interest designation, and thus subsequent risk-based screening evaluations, due to questions about the consistency and reliability of the measurements, as discussed in Section 3.2. Acrolein is not a target analyte for the SNMOC method. Although acrolein has the highest toxicity-weighted emissions for all but two counties with an NMP site, it does not often appear among the highest emitted pollutants. Mesa and Garfield Counties are two of only five counties with an NMP site for which acrolein ranks among the 10 highest emitted. The acrolein emissions for Garfield County are the third highest among counties with NMP sites (behind only Cook County, Illinois and Los Angeles County, California). A similar observation was made in previous NMP reports.

- Five of the highest emitted pollutants in Mesa County (including acrolein) also have the highest toxicity-weighted emissions. Six of the 10 highest emitted pollutants in Garfield County (including acrolein) also have the highest toxicity-weighted emissions. Toluene, the highest emitted pollutant for Mesa County and third highest emitted pollutant in Garfield County, is not among those pollutants with the highest

toxicity-weighted emissions. Several metals appear near the bottom of each toxicity-weighted emissions list for each county but do not appear among the highest emitted.

- Formaldehyde, acetaldehyde, and benzene are pollutants of interest for GPCO that appear on all three lists in Table 7-6. Naphthalene and 1,3-butadiene appear among the pollutants with the highest noncancer hazard approximations and highest toxicity-weighted emissions but are not among the highest emitted pollutants with a noncancer RfC in Mesa County. This is also true for arsenic.

- Each of the pollutants of interest identified for the Garfield County sites appear on both emissions-based lists in Table 7-6, with one exception. Ethylbenzene is a pollutant of interest for RICO. Ethylbenzene appears among the pollutants with the highest emissions in Garfield County, but is not among those with the 10 highest toxicity-weighted emissions.

7.5 Summary of the 2015-2016 Monitoring Data for the Colorado Monitoring Sites

Results from several of the data analyses described in this section include the following:

- ❖ *Twenty pollutants failed screens for GPCO. The number of pollutants failing screens for the Garfield County sites ranged from three to five.*

- ❖ *Among GPCO's pollutants of interest, dichloromethane had the highest concentrations measured, particularly for 2015. Dichloromethane, formaldehyde, and acetaldehyde are the only pollutants with annual average concentrations greater than 1 µg/m^3.*

- ❖ *Among the Garfield County sites, RICO and PACO had the highest annual average concentrations of benzene and formaldehyde, the only pollutants of interest for these sites with annual average concentrations greater than 1 µg/m^3. PACO had the second (2015) and third (2016) highest annual average concentrations of benzene among all NMP sites sampling this pollutant.*

- ❖ *GPCO and four Garfield County sites have sampled under the NMP for at least 5 years. Notable trends for these sites include: The 1-year average concentrations for several pollutants for GPCO are at a minimum for 2016, including acenaphthene, benzene, 1,3-butadiene, ethylbenzene, and naphthalene. The significant increase in the detection rate of 1,2-dichloroethane beginning in 2012 continues through 2016. The highest fluoranthene concentrations measured since the onset of sampling, were measured at GPCO in 2015 and 2016. Concentrations of acetaldehyde and formaldehyde decreased considerably at BRCO in 2016. Concentrations of acetaldehyde appear to have a decreasing trend at PACO. The detection rate of 1,3-butadiene has decreased considerably at PACO and RFCO, particularly in 2016.*

- ❖ *Formaldehyde had the highest cancer risk approximations among the pollutants of interest for GPCO. Benzene and formaldehyde have the highest cancer risk approximations for the Garfield County sites, depending on the year and whether annual average concentrations could be calculated. None of the pollutants of interest for the Colorado monitoring sites have noncancer hazard approximations greater than an HQ of 1.0.*

8.0 Site in the District of Columbia

This section summarizes those data from samples collected at the NATTS site in Washington, D.C. and generated by ERG, EPA's contract laboratory for the NMP, over the 2015 and 2016 monitoring efforts. This section also examines the spatial and temporal characteristics of the ambient monitoring concentrations and reviews them through the context of risk. Readers are encouraged to refer to Sections 1 through 4 for detailed discussions and definitions regarding the various data analyses presented below.

Data generated by sources other than ERG, EPA's contract laboratory for the NMP, are not included in the data analyses contained in this report.

8.1 Site Characterization

This section characterizes the Washington, D.C. monitoring site by providing a description of the nearby area surrounding the monitoring site; plotting emissions sources surrounding the monitoring site; and presenting traffic data and other characterizing information for the site. This information is provided to give the reader insight regarding factors that may influence the air quality near the site and assist in the interpretation of the ambient measurements.

Figure 8-1 presents a composite satellite image retrieved from ArcGIS Explorer showing the monitoring site and its immediate surroundings. Figure 8-2 identifies nearby point source emissions locations by source category, as reported in the 2014 NEI for point sources, version 1. Note that only sources within 10 miles of the site are included in the facility counts provided in Figure 8-2. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have a direct effect on the air quality at the monitoring site. Further, this boundary provides both the proximity of emissions sources to the monitoring site as well as the quantity of such sources within a given distance of the site. Sources outside the 10-mile boundary are still visible on the map for reference but have been grayed out to emphasize emissions sources within the boundary. Table 8-1 provides supplemental geographical information such as land use, location setting, and locational coordinates. Each figure and table is discussed in detail in the paragraphs that follow.

Figure 8-1. Washington, D.C. (WADC) Monitoring Site

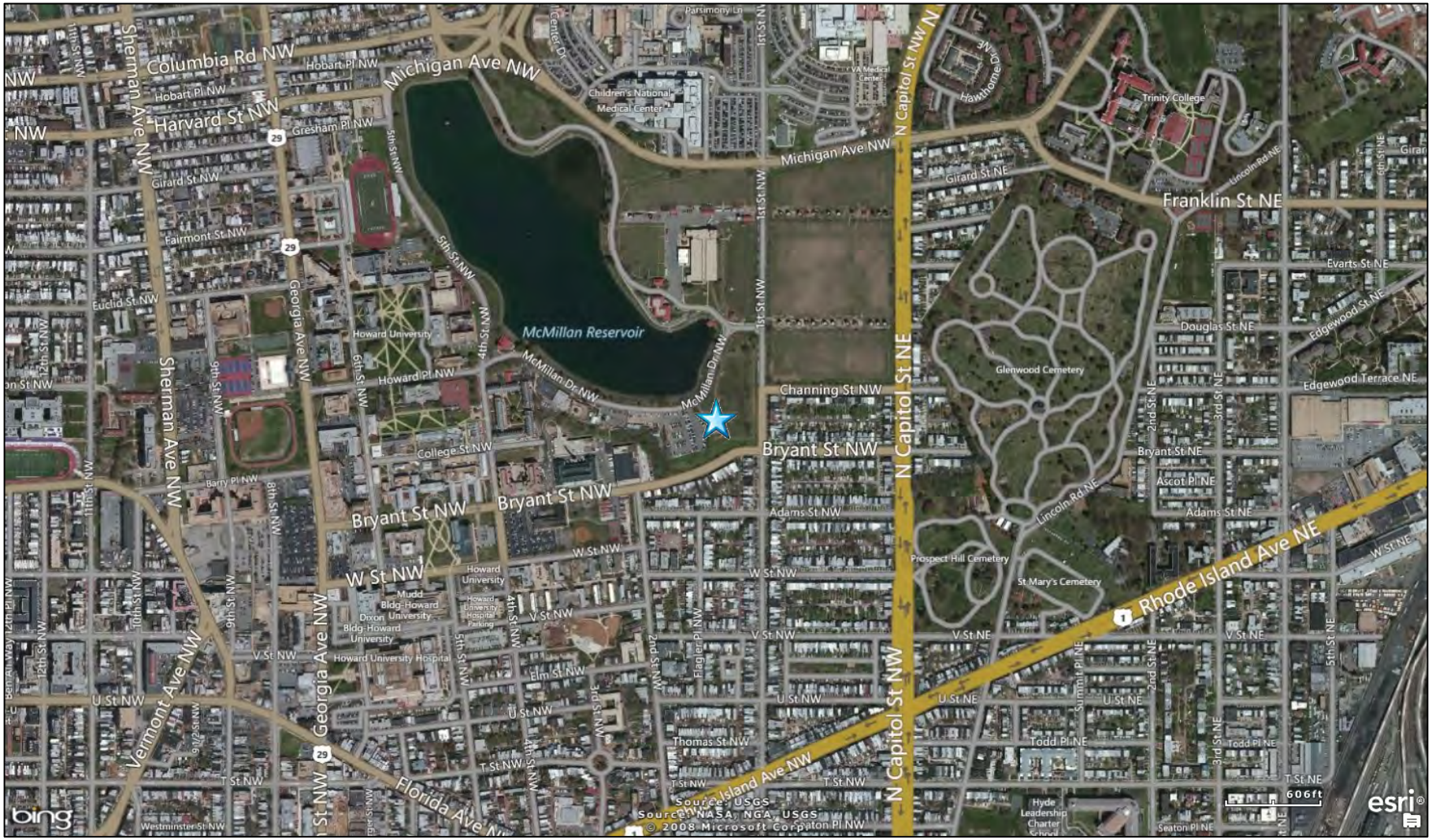


Figure 8-2. NEI Point Sources Located Within 10 Miles of WADC

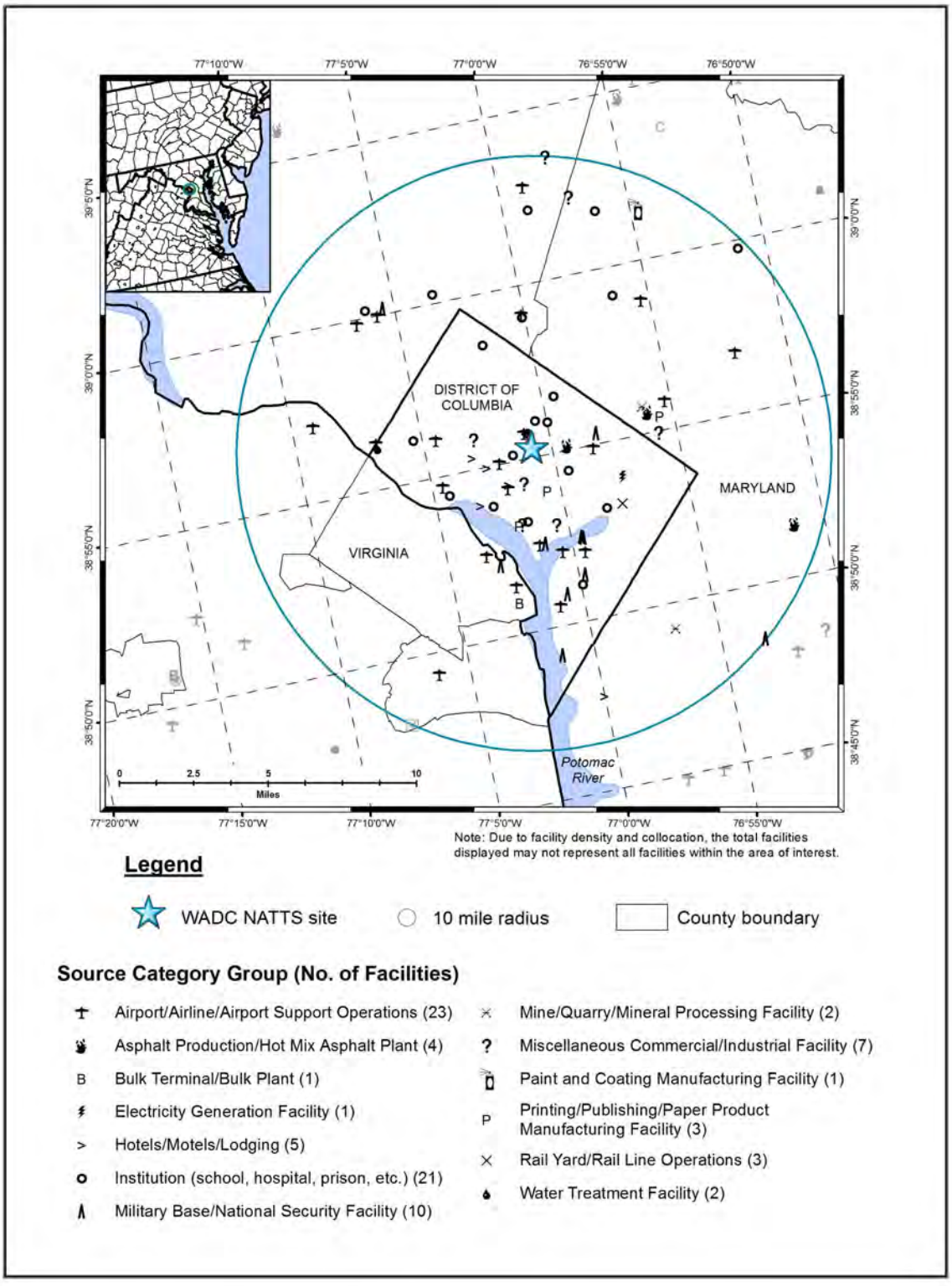


Table 8-1. Geographical Information for the Washington, D.C. Monitoring Site

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Annual Average Daily Traffic[1]	Intersection Used for Traffic Data
WADC	11-001-0043	Washington	District Of Columbia	Washington-Arlington-Alexandria, DC-VA-MD-WV	38.921847, -77.013178	Commercial	Urban/City Center	3,600	Bryant St NW at First St

[1]AADT reflects 2014 data (DC DOT, 2015)
BOLD ITALICS = EPA-designated NATTS Site

Figure 8-1 shows that the WADC monitoring site is located in an open field at the southeast end of the McMillan Water Reservoir in Washington, D.C. It is also located within a short distance of several heavily traveled roadways. The site is located in a commercial area, and is surrounded by a hospital, a cemetery, and a university. The First Street Tunnel Project, a construction project which commenced to reduce sewer flooding in nearby neighborhoods, was completed in October 2016 (DC WSA, 2017).

As Figure 8-2 shows, WADC is surrounded by a number of emissions sources, many of which are included in three sources categories: 1) the airport and airport support operations source category, which includes airports and related operations as well as small runways and heliports, such as those associated with hospitals or televisions stations; 2) the institution source category, which includes hospitals, schools, and prisons; and 3) the military bases and national security facilities source category. The closest sources to WADC are a wastewater treatment facility, hospitals, and heliports at hospitals.

In addition to providing city, county, CBSA, and land use/location setting information, Table 8-1 also contains traffic volume information for the site as well as the location for which the traffic volume was obtained. This information is provided because emissions from motor vehicles can significantly affect concentrations measured at a given monitoring site. The traffic volume experienced near WADC is less than 4,000 vehicles and is among the 10 lowest compared to other NMP sites. The traffic volume provided is for Bryant Street NW at First Street NW, the closest intersection east of the monitoring site. The tunnel project may have affected typical traffic patterns in the area during construction.

8.2 Pollutants of Interest

The risk-based screening process described in Section 3.2 was performed for each site to identify site-specific "pollutants of interest," which allows analysts and readers to focus on a subset of pollutants through the context of risk. Each pollutant's preprocessed daily measurement was compared to its associated risk screening value. If the concentration was greater than the risk screening value, then the concentration "failed the screen." The site-specific results of this risk-based screening process are presented in Table 8-2 and incorporate measurements from both 2015 and 2016. Pollutants of interest are those for which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens and are shaded in gray in Table 8-2. It is important to note which pollutants were sampled for at each site when reviewing the results of this analysis. PAHs were sampled for at WADC in 2015 and 2016.

Table 8-2. 2015-2016 Risk-Based Screening Results for the Washington, D.C. Monitoring Site

Pollutant	Screening Value (µg/m^3)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Washington, D.C. - WADC						
Naphthalene	0.029	107	118	90.68	98.17	98.17
Benzo(a)pyrene	0.00057	2	99	2.02	1.83	100.00
Total		109	217	50.23		

Observations from Table 8-2 include the following:

- Concentrations of two PAHs failed screens for WADC: naphthalene, and benzo(a)pyrene.
- Concentrations of naphthalene failed nearly 91 percent of screens, while concentrations of benzo(a)pyrene failed 2 percent of screens.
- Naphthalene accounted for more than 98 percent of the total failed screens for WADC; thus, naphthalene is WADC's only pollutant of interest.

For each of the data analyses described in the remaining sections, the focus is on the site-specific pollutant(s) of interest identified via the risk-based screening process, as described in Section 3.4.2.

8.3 Concentrations

This section presents various concentration averages used to characterize air toxics concentration levels at the Washington, D.C. monitoring site. Where applicable, the following calculations and data analyses were performed for each of the site-specific pollutants of interest:

- Time period-based concentration averages (quarterly and annual) are provided for each monitoring site for each year.
- The range of measurements and annual concentration averages are presented graphically for each site to illustrate how the site's concentrations compare to the program-level averages, as presented in Section 4.1.
- Concentration averages and other statistical metrics for 2015, 2016, and from previous years of monitoring are presented in order to characterize concentration trends at each site.

Each data analysis is performed where the applicable criteria are met (as specified in the appropriate sections discussed below) and is limited to the site-specific pollutants of interest. Site-specific statistical summaries for all pollutants sampled for at WADC are provided in Appendix N.

8.3.1 2015 and 2016 Concentration Averages

Quarterly and annual average concentrations for 2015 and 2016 were calculated for the pollutants of interest for the Washington, D.C. monitoring site, as described in Section 3.1. The *quarterly average concentration* of a particular pollutant is simply the average concentration of the preprocessed daily measurements over a given calendar quarter. Quarterly average concentrations include the substitution of zeros for all non-detects. A site must have a minimum of 75 percent valid samples compared to the total number of samples possible within a given calendar quarter for a quarterly average to be calculated. An *annual average concentration* includes all measured detections and substituted zeros for non-detects for an entire year of sampling. Annual average concentrations were calculated for pollutants where three valid quarterly averages could be calculated for a given year and where method completeness was greater than or equal to 85 percent, as presented in Section 2.4. Quarterly and annual average concentrations for the pollutant of interest for WADC are presented in Table 8-3, where applicable. Note that if a pollutant was not detected in a given calendar quarter, the quarterly average simply reflects "0" because only zeros substituted for non-detects were factored into the quarterly average concentration.

Observations for WADC from Table 8-3 include the following:

- Naphthalene was detected in every valid PAH sample collected at WADC.
- Concentrations of naphthalene measured at WADC range from 16.0 ng/m^3 to 257 ng/m^3.
- The annual average concentration of naphthalene for 2015 is similar the annual average concentration for 2016.
- A comparison of both years' quarterly average concentrations shows that the fourth quarter average is the highest quarterly average for both years and has the largest confidence intervals. For 2015, both the minimum and maximum concentrations of naphthalene were measured during the fourth quarter of the year, including all six naphthalene concentrations greater than 100 ng/m^3. For 2016, nine naphthalene concentrations greater than 100 ng/m^3 were measured, four each during the first and fourth quarters, with an additional one measured during the second quarter. Again, the minimum concentration was measured during the fourth quarter. Even though the maximum concentration of naphthalene was not measured during the fourth quarter in 2016, the second, third, and fourth highest naphthalene concentrations measured in 2016 were measured during the fourth quarter.

Table 8-3. Quarterly and Annual Average Concentrations of the Pollutants of Interest for the Washington, D.C. Monitoring Site

Pollutant	2015						2016					
	# of Detects/ # >MDL/ # Samples	Q1 Avg (ng/m^3)	Q2 Avg (ng/m^3)	Q3 Avg (ng/m^3)	Q4 Avg (ng/m^3)	Annual Average (ng/m^3)	# of Detects/ # >MDL/ # Samples	Q1 Avg (ng/m^3)	Q2 Avg (ng/m^3)	Q3 Avg (ng/m^3)	Q4 Avg (ng/m^3)	Annual Average (ng/m^3)
Washington, D.C. - WADC												
Naphthalene	60/60/60	58.61 ± 10.31	47.73 ± 5.07	50.68 ± 9.30	82.09 ± 27.37	60.56 ± 8.81	58/58/58	73.84 ± 32.90	52.85 ± 13.68	45.79 ± 9.53	83.97 ± 30.00	65.23 ± 12.52

8.3.2 Concentration Comparison

In order to better illustrate how each site's annual average concentrations compare to the program-level averages, a site-specific box plot was created for each of the site-specific pollutants of interest, where applicable. Thus, a box plot was created for naphthalene for WADC. Figure 8-3 overlays the site's minimum, annual average, and maximum naphthalene concentrations for each year onto the program-level minimum, first quartile, median, average, third quartile, and maximum concentrations, as described in Section 3.4.2.1, and are discussed below. If an annual average concentration could not be calculated, the range of concentrations is still provided in the figure(s) that follow.

Figure 8-3. Program vs. Site-Specific Average Naphthalene Concentrations

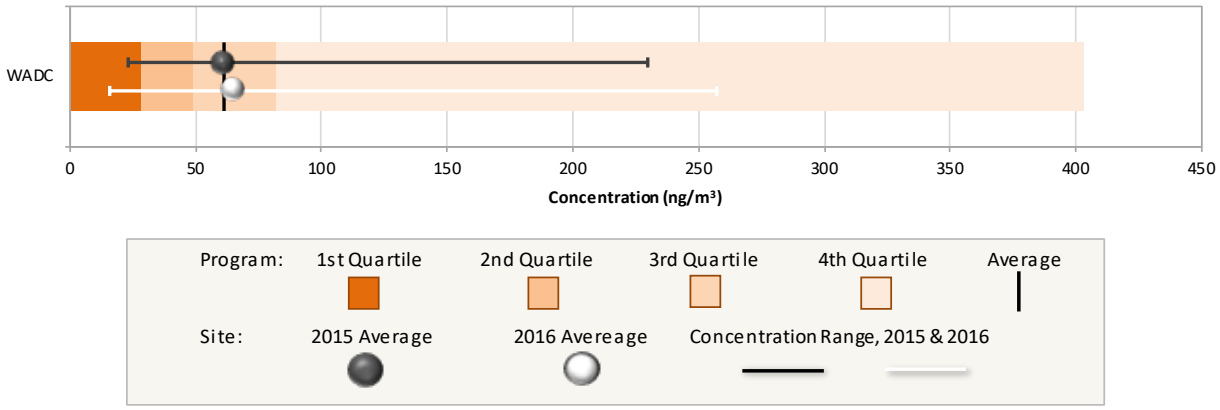


Figure 8-3 presents the box plot for naphthalene for WADC and shows the following:

- The range of naphthalene concentrations measured at WADC in 2016 is slightly larger than the range measured in 2015. The maximum naphthalene concentrations measured at WADC in both years are considerably less than the program-level maximum concentration (403 ng/m^3).

- The annual average concentration of naphthalene for 2015 is similar to the program-level average concentration (61.23 ng/m^3), while the annual average for 2016 is just slightly higher.

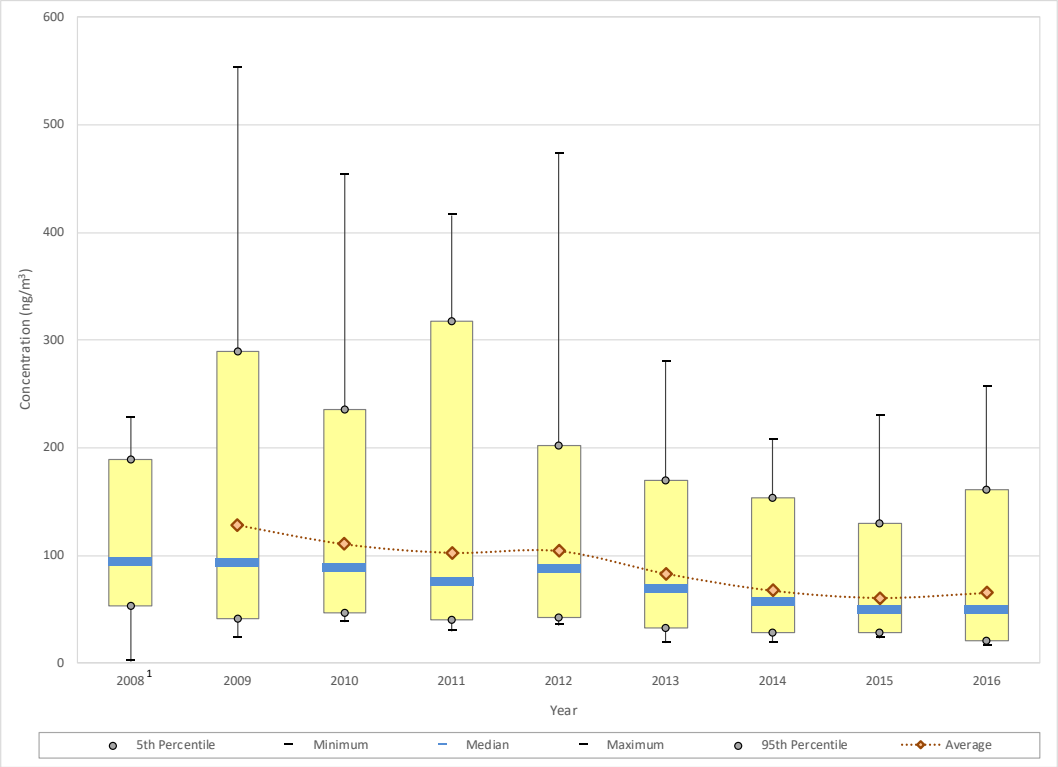
- There were no non-detects of naphthalene measured at WADC, or across the program.

8.3.3 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the pollutants of interest for 5 consecutive years or longer, as described in Section 3.4.2.2. WADC has sampled PAHs under the NMP since mid-2008. Thus, Figure 8-4 presents the 1-year statistical metrics for naphthalene for WADC. The statistical metrics presented for assessing

trends include the substitution of zeros for non-detects. If sampling began mid-year, a minimum of 6 months of sampling is required for inclusion in the trends analysis; in these cases, a 1-year average concentration is not provided, although the range and percentiles are still presented.

Figure 8-4. Yearly Statistical Metrics for Naphthalene Concentrations Measured at WADC



[1] A 1-year average is not presented because sampling under the NMP did not begin until late June 2008.

Observations from Figure 8-4 for naphthalene concentrations measured at WADC include the following:

- WADC began sampling PAHs under the NMP in late June 2008. Because a full year's worth of data is not available, a 1-year average concentration for 2008 is not presented, although the range of measurements is provided.

- The maximum naphthalene concentration was measured in 2009 and is the only concentration greater than 500 ng/m^3 measured at this site (553 ng/m^3). Concentrations greater than 400 ng/m^3 were measured in each year of sampling between 2009 and 2012, after which concentrations greater than 300 ng/m^3 were not measured.

- The 1-year average concentrations exhibit a significant decreasing trend over the years of sampling, decreasing by more than half over the period, from a maximum of 128.63 ng/m^3 in 2009 to a minimum of 60.56 ng/m^3 in 2015. A slight uptick is shown in the 1-year average concentration for 2012 before the decreasing trend resumes; less than 2 ng/m^3 separates the 2011 and 2012 averages. A similar observation can be made for 2016.

- The median concentration exhibits a similar pattern as the 1-year average concentration, though the increase from 2011 to 2012 is larger. The median concentration is less than 100 ng/m^3 for each year shown in Figure 8-4, and is less than 50 ng/m^3 for 2015 and 2016.

8.4 Additional Risk-Based Screening Evaluations

The following risk-based screening evaluations were conducted to characterize risk related to the air toxics measured at the WADC monitoring site. Refer to Sections 3.2, 3.4.2.3, and 3.4.2.4 for definitions and explanations regarding the various toxicity factors, time frames, and calculations associated with these risk-based screenings.

8.4.1 Cancer Risk and Noncancer Hazard Approximations

For the pollutant(s) of interest for WADC, risk was examined by calculating cancer risk and noncancer hazard approximations for each year annual average concentrations could be calculated. These approximations can be used as risk estimates for cancer and noncancer effects attributable to the pollutants of interest. Although the use of these approximations is limited, they may help identify where policy-makers want to shift their air monitoring priorities. Refer to Section 3.4.2.3 for an explanation of how cancer risk and noncancer hazard approximations are calculated and what limitations are associated with them. Annual averages, cancer UREs and/or noncancer RfCs, and cancer risk and noncancer hazard approximations are presented in Table 8-4, where applicable. Cancer risk approximations are presented as probabilities while the noncancer hazard approximations are ratios and thus, unitless values.

Observations for WADC from Table 8-4 include the following:

- The annual average concentrations of naphthalene for WADC fall in the middle of the range compared to annual average concentrations for other NMP sites sampling this pollutant.

- The cancer risk approximations for naphthalene are 2.06 in-a-million for 2015 and 2.22 in-a-million for 2016.

- The noncancer hazard approximations for naphthalene are significantly less than 1.0 (0.02 for both years), indicating that no adverse noncancer health effects are expected from this individual pollutant.

Table 8-4. Risk Approximations for the Washington, D.C. Monitoring Site

Pollutant	Cancer URE ($\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	2015				2016			
			# of Measured Detections vs. # of Samples	Annual Average (ng/m^3)	Risk Approximations		# of Measured Detections vs. # of Samples	Annual Average (ng/m^3)	Risk Approximations	
					Cancer (in-a-million)	Noncancer (HQ)			Cancer (in-a-million)	Noncancer (HQ)
Washington, D.C. - WADC										
Naphthalene	0.000034	0.003	60/60	60.56 ± 8.81	2.06	0.02	58/58	65.23 ± 12.52	2.22	0.02

8.4.2 Risk-Based Emissions Assessment

In addition to the risk-based screening discussed above, this section presents an evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 8-5 presents the 10 pollutants with the highest emissions from the 2014 NEI (version 1) that have cancer toxicity factors. Table 8-5 also presents the 10 pollutants with the highest toxicity-weighted emissions, based on the weighting schema described in Section 3.4.2.4. Lastly, Table 8-5 provides the cancer risk approximations (in-a-million) for the pollutant of interest for WADC, as presented in Table 8-4. Cancer risk approximations for 2015 are presented in green while approximations for 2016 are in white. The emissions, toxicity-weighted emissions, and cancer risk approximations are shown in descending order in Table 8-5. Table 8-6 presents similar information, but is limited to those pollutants with noncancer toxicity factors.

Because not all pollutants have both cancer and noncancer toxicity factors, the highest emitted pollutants in the cancer table may be different from the noncancer table, although the actual quantity of emissions is the same. The cancer risk and noncancer hazard approximations based on each site's annual averages are limited to the pollutants of interest identified for each site. In addition, the cancer risk and noncancer hazard approximations are limited to those pollutants with enough data to meet the criteria for annual averages to be calculated. A more in-depth discussion of this analysis is provided in Section 3.4.2.4. Similar to the cancer risk and noncancer hazard approximations provided in Section 8.4.1, this analysis may help policy-makers prioritize their air monitoring activities.

Table 8-5. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Washington, D.C. Monitoring Site

Top 10 Total Emissions for Pollutants with Cancer UREs (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Washington, D.C. (District of Columbia) - WADC					
Benzene	92.37	Formaldehyde	1.20E-03	Naphthalene	2.22
Formaldehyde	91.97	Benzene	7.20E-04	Naphthalene	2.06
Ethylbenzene	49.50	1,3-Butadiene	3.88E-04		
Acetaldehyde	48.19	Naphthalene	2.58E-04		
1,3-Butadiene	12.93	POM, Group 2b	1.50E-04		
Naphthalene	7.58	POM, Group 2d	1.28E-04		
POM, Group 2b	1.71	Ethylbenzene	1.24E-04		
POM, Group 2d	1.45	Acetaldehyde	1.06E-04		
Trichloroethylene	0.18	POM, Group 5a	9.87E-05		
POM, Group 6	0.17	Arsenic, PM	8.95E-05		

[1] Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Table 8-6. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the Washington, D.C. Monitoring Site

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Hazard Approximation (HQ)**
Washington, D.C. (District of Columbia) - WADC					
Toluene	335.28	Acrolein	309,020.44	Naphthalene	0.02
Methanol	294.90	Formaldehyde	9,384.59	Naphthalene	0.02
Xylenes	179.06	1,3-Butadiene	6,464.65		
Ethylene glycol	101.49	Acetaldehyde	5,354.92		
Benzene	92.37	Benzene	3,079.01		
Formaldehyde	91.97	Naphthalene	2,526.39		
Hexane	67.97	Xylenes	1,790.63		
Ethylbenzene	49.50	Arsenic, PM	1,387.77		
Acetaldehyde	48.19	Cadmium, PM	1,106.59		
Glycol ethers, gas	13.59	Propionaldehyde	842.80		

[1] Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Observations from Table 8-5 include the following:

- Benzene and formaldehyde are the highest emitted pollutants with cancer UREs in the District of Columbia. Formaldehyde and benzene are the pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs).

- Eight of the highest emitted pollutants also have the highest toxicity-weighted emissions.

- Naphthalene is the only pollutant of interest for WADC. This pollutant appears on both emissions-based lists. Naphthalene is the sixth highest emitted pollutant with a cancer URE in the District of Columbia and has the fourth highest toxicity-weighted emissions (of the pollutants with cancer UREs).

- Several POM Groups are among the highest emitted "pollutants" in the District and/or rank among the pollutants with the highest toxicity-weighted emissions. POM, Groups 2b and 6 includes several PAHs sampled for at WADC, although none of these failed screens. POM, Group 5a includes benzo(a)pyrene, which failed two screens but was not identified as a pollutant of interest for WADC. POM, Group 2d does not include any PAHs sampled for at WADC.

Observations from Table 8-6 include the following:

- Toluene and methanol are the highest emitted pollutants with noncancer RfCs in the District of Columbia.

- The pollutants with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) are acrolein, formaldehyde, and 1,3-butadiene.

- Four of the highest emitted pollutants in the District of Columbia also have the highest toxicity-weighted emissions.

- Naphthalene has the sixth highest toxicity-weighted emissions but is not one of the 10 highest emitted pollutants (of the pollutants with noncancer RfCs).

- None of the other pollutants sampled for at WADC under the NMP appear in Table 8-6.

8.5 Summary of the 2015-2016 Monitoring Data for WADC

Results from several of the data analyses described in this section include the following:

- ❖ *Concentrations of two PAHs failed screens, with naphthalene failing the majority of screens and therefore is the only pollutant of interest identified via the risk screening process.*

- ❖ *The annual average concentration of naphthalene for 2015 is similar the annual average concentration for 2016 and both fall in the middle of the range compared to annual average concentrations for other NMP sites sampling this pollutant.*

- ❖ *Concentrations of naphthalene have an overall decreasing trend at WADC.*

- *Both cancer risk approximations for naphthalene are approximately 2 in-a-million; the noncancer hazard approximations for naphthalene are significantly less than an HQ of 1.0.*

9.0 Sites in Florida

This section summarizes those data from samples collected at the NATTS and UATMP sites in Florida and generated by ERG, EPA's contract laboratory for the NMP, over the 2015 and 2016 monitoring efforts. This section also examines the spatial and temporal characteristics of the ambient monitoring concentrations and reviews them through the context of risk. Readers are encouraged to refer to Sections 1 through 4 for detailed discussions and definitions regarding the various data analyses presented below.

Data generated by sources other than ERG, EPA's contract laboratory for the NMP, are not included in the data analyses contained in this report.

9.1 Site Characterization

This section characterizes the Florida monitoring sites by providing a description of the nearby area surrounding each monitoring site; plotting emissions sources surrounding the monitoring sites; and presenting traffic data and other characterizing information for each site. This information is provided to give the reader insight regarding factors that may influence the air quality near the sites and assist in the interpretation of the ambient measurements.

The five Florida sites are located in two separate urban areas; AZFL, SKFL, and SYFL are located in the Tampa-St. Petersburg-Clearwater, Florida CBSA, ORFL and PAFL are located in the Orlando-Kissimmee-Sanford, Florida CBSA. Figures 9-1 and 9-2 present composite satellite images retrieved from ArcGIS Explorer showing the St. Petersburg area monitoring sites and their immediate surroundings. Figure 9-3 identifies nearby point source emissions locations that surround these two sites by source category, as reported in the 2014 NEI for point sources, version 1. Note that only sources within 10 miles of the sites are included in the facility counts provided in Figure 9-3. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have a direct effect on the air quality at the monitoring sites. Further, this boundary provides both the proximity of emissions sources to the monitoring sites as well as the quantity of such sources within a given distance of the sites. Sources outside the 10-mile boundaries are still visible on the map for reference but have been grayed out to emphasize emissions sources within the boundaries. Figures 9-4 through 9-8 present the composite satellite images and emissions sources maps for the Tampa site and the two sites in the Orlando area. Table 9-1 provides supplemental geographical information such as land use, location setting, and locational coordinates. Each figure and table is discussed in detail in the paragraphs that follow.

Figure 9-1. St. Petersburg, Florida (AZFL) Monitoring Site

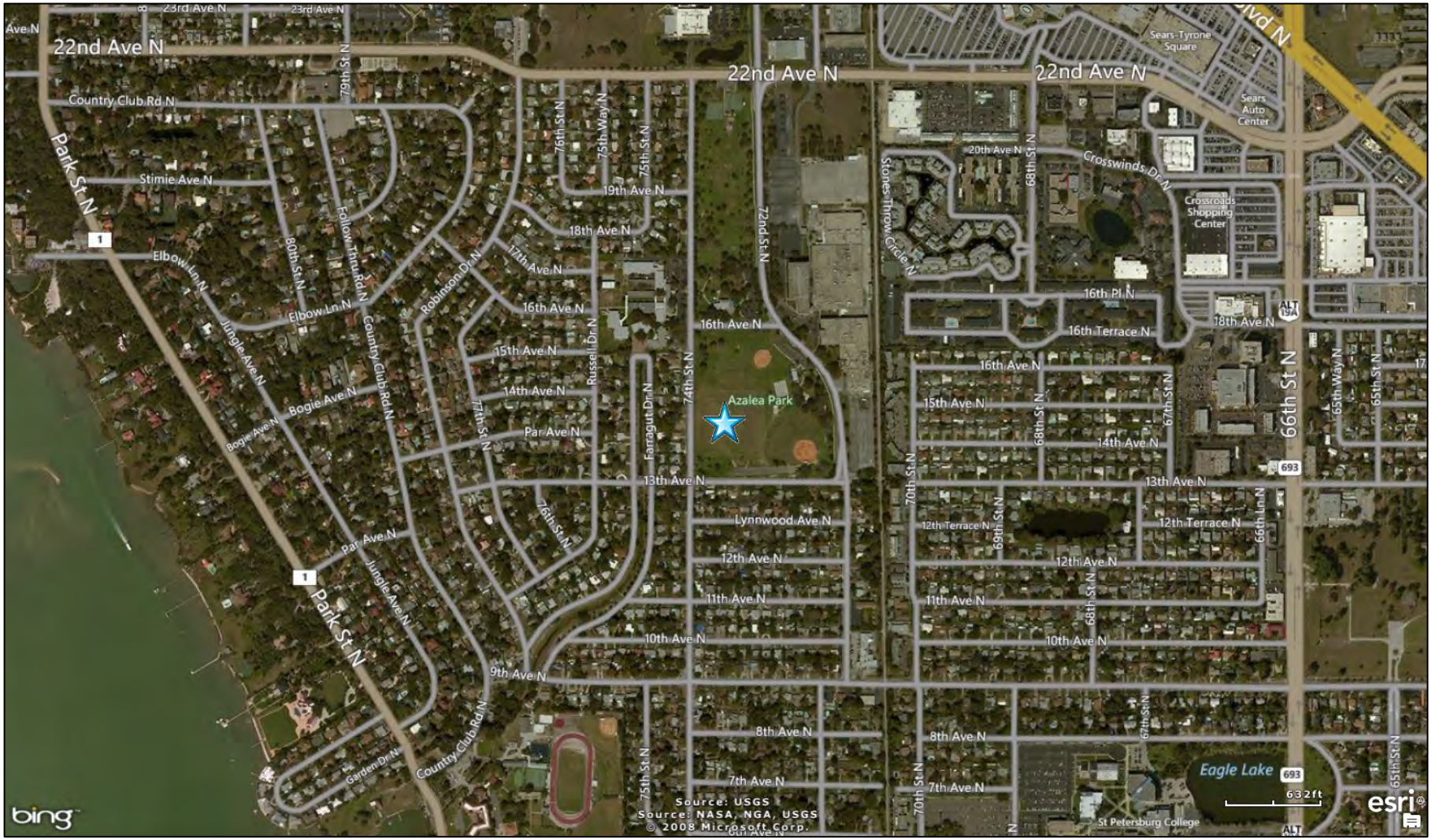


Figure 9-2. Pinellas Park, Florida (SKFL) Monitoring Site

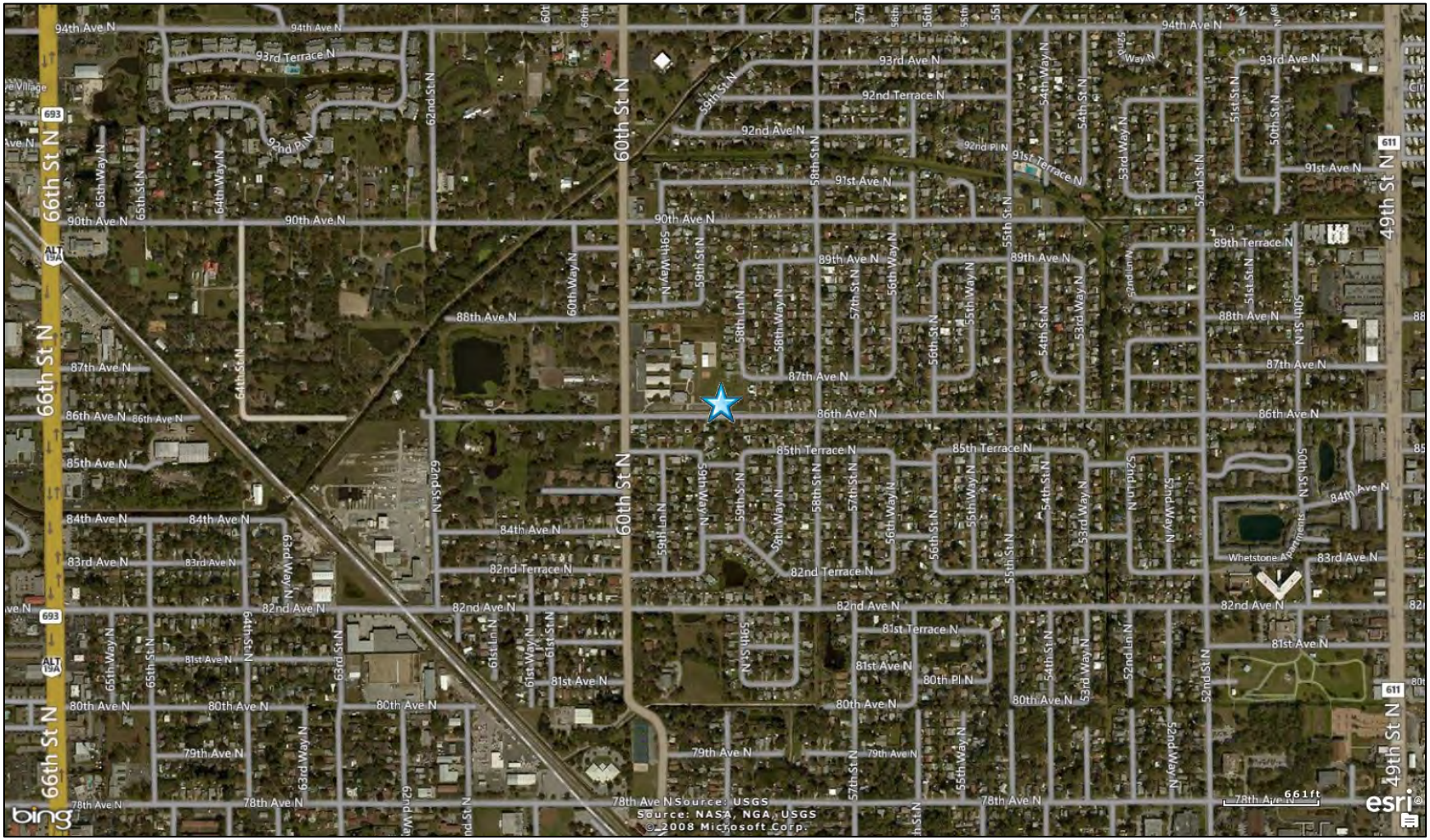


Figure 9-3. NEI Point Sources Located Within 10 Miles of AZFL and SKFL

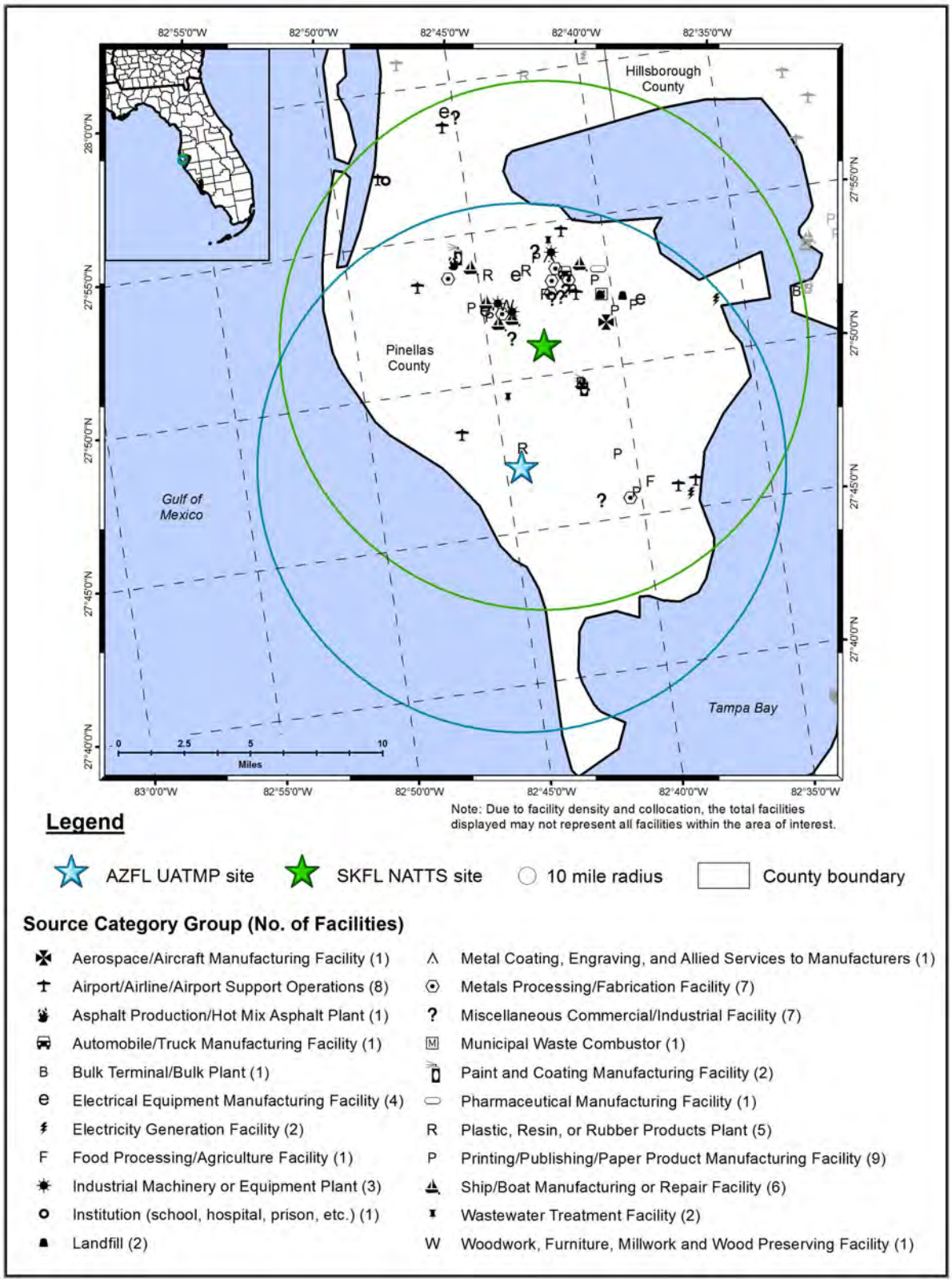


Figure 9-4. Valrico, Florida (SYFL) Monitoring Site

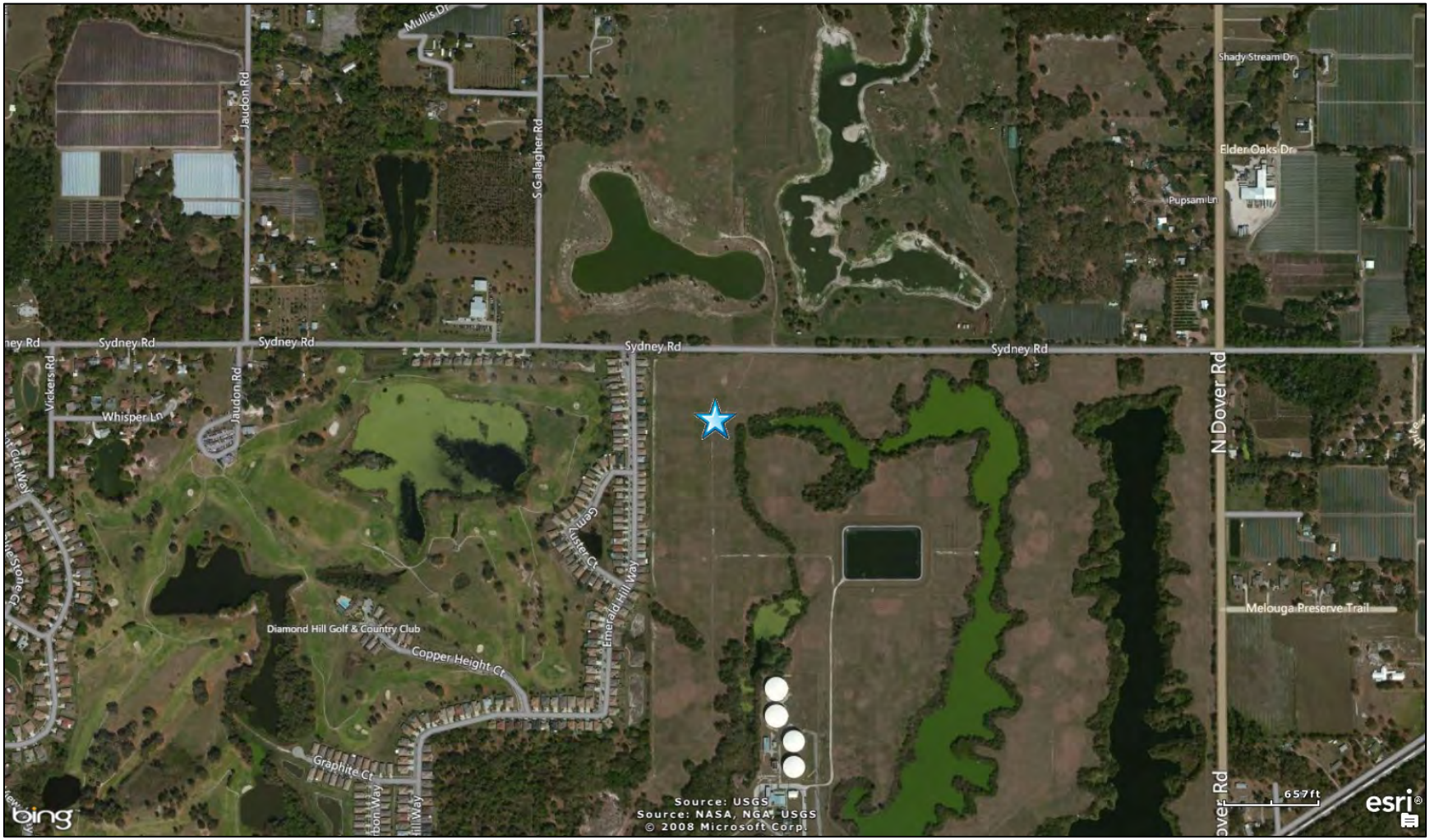


Figure 9-5. NEI Point Sources Located Within 10 Miles of SYFL

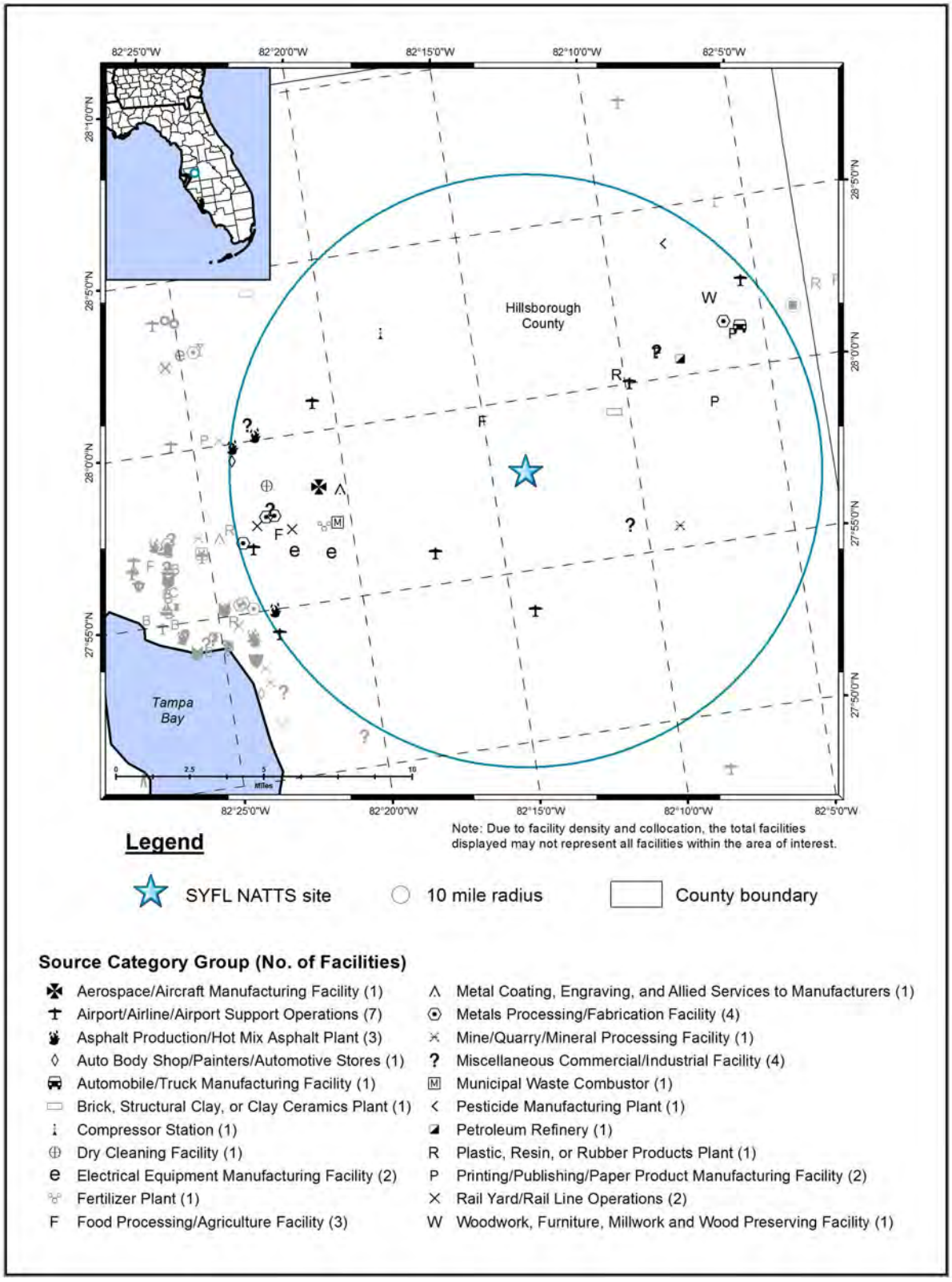


Figure 9-6. Winter Park, Florida (ORFL) Monitoring Site

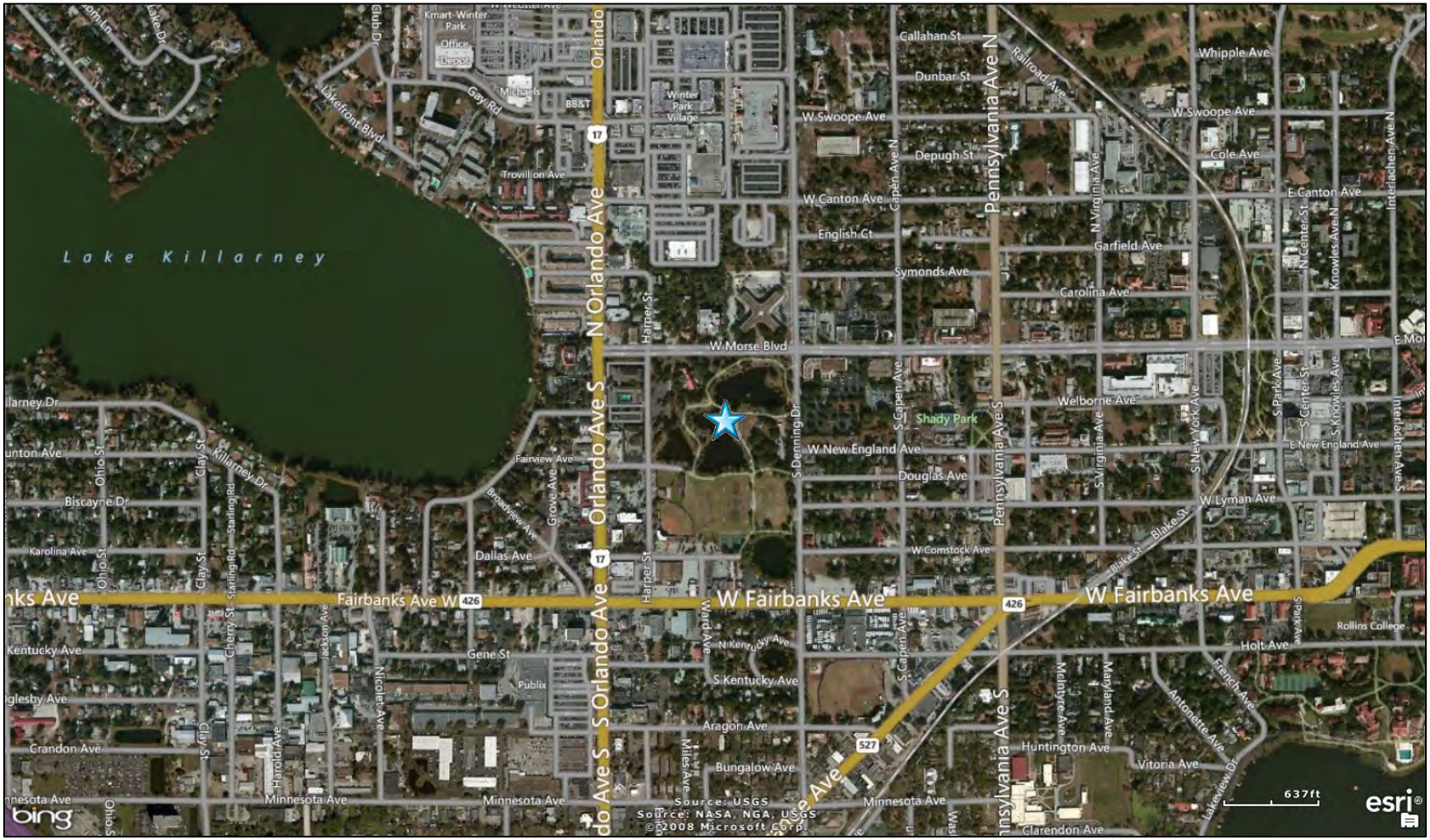


Figure 9-7. Orlando, Florida (PAFL) Monitoring Site

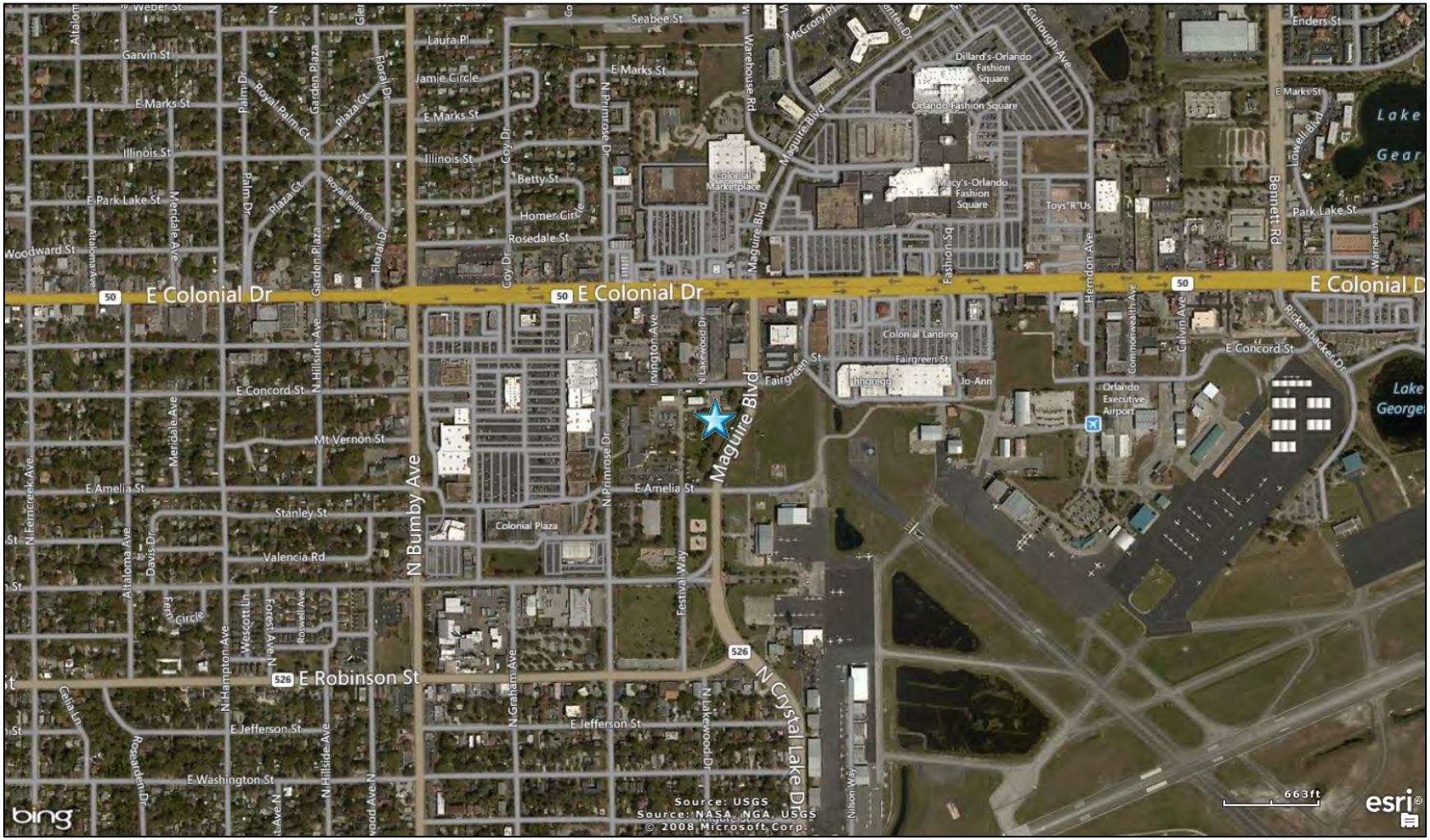


Figure 9-8. NEI Point Sources Located Within 10 Miles of ORFL and PAFL

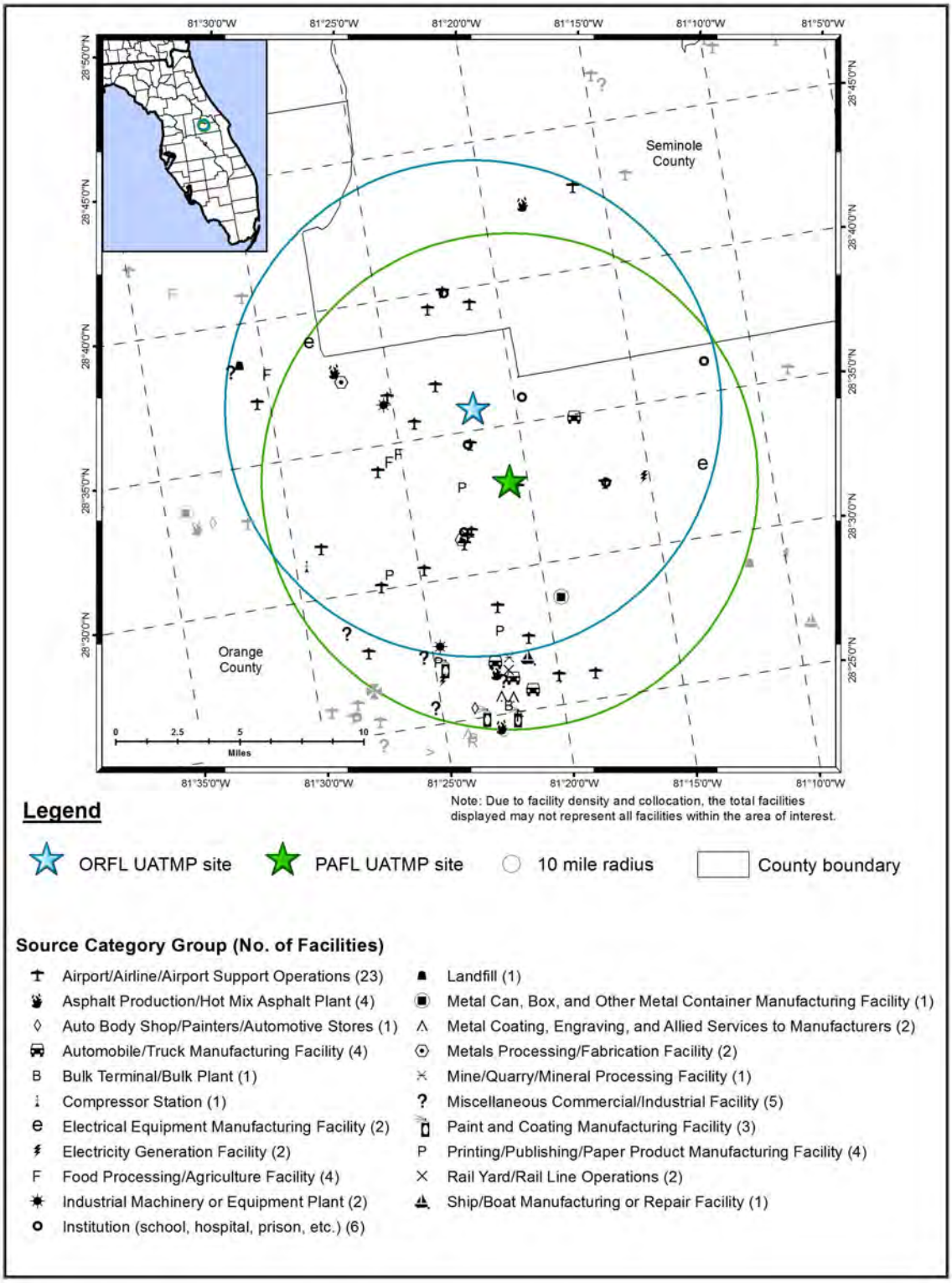


Table 9-1. Geographical Information for the Florida Monitoring Sites

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Annual Average Daily Traffic[1]	Intersection Used for Traffic Data
AZFL	12-103-0018	St. Petersburg	Pinellas	Tampa-St. Petersburg-Clearwater, FL	27.785866, -82.739875	Residential	Suburban	3,100[2]	9th Ave N, W of Park St N
SKFL	12-103-0026	Pinellas Park	Pinellas	Tampa-St. Petersburg-Clearwater, FL	27.850348, -82.714465	Residential	Suburban	4,000[2]	60th St N, N of 82 Ave N
SYFL	12-057-3002	Valrico	Hillsborough	Tampa-St. Petersburg-Clearwater, FL	27.965650, -82.230400	Residential	Rural	3,900	Sydney Road, W of S Forbes Rd
ORFL	12-095-2002	Winter Park	Orange	Orlando-Kissimmee-Sanford, FL	28.596389, -81.362500	Commercial	Urban/City Center	33,000	Orlando Ave, N of Morse Blvd
PAFL	12-095-1004	Orlando	Orange	Orlando-Kissimmee-Sanford, FL	28.550833, -81.345556	Commercial	Suburban	50,000	Colonial/MLK Blvd, b/w Primrose Rd & Bumby Ave

[1]AADT reflects 2016 data (FL DOT, 2016)

[2] Previous traffic count location moved to closer location; reflects a large decrease.

BOLD ITALICS = EPA-designated NATTS Site

AZFL is located at Azalea Park in St. Petersburg. Figure 9-1 shows that the area surrounding AZFL consists of mixed land use, including residential, commercial, and industrial properties. The industrial property separated from Azalea Park by 72nd Street North is a former electronics manufacturer and a permanently closed facility, and was purchased in 2015 by a commercial redevelopment company (Girardi, 2015). Heavily traveled roadways are located less than 1 mile from the monitoring site. AZFL is located less than 1 mile east of Boca Ciega Bay, the edge of which can be seen in the bottom-left corner of Figure 9-1.

SKFL is located in Pinellas Park, north of St. Petersburg. This site is located on the property of Skyview Elementary School, at the corner of 86th Avenue North and 60th Street North. Figure 9-2 shows that SKFL is located in a primarily residential area. A rail line intersects the Pinellas Park Ditch near a construction company on the left-hand side of Figure 9-2. Population exposure is the purpose behind monitoring at this location. This site is the Pinellas County NATTS site.

Figure 9-3 shows the location of the St. Petersburg sites in relation to each other. AZFL is located approximately 5 miles south-southwest of SKFL. Most of the emissions sources on the Tampa Bay Peninsula are located north of SKFL. A small cluster of point sources is also located southeast of SKFL. The source categories with the greatest number of emissions sources in the St. Petersburg area (based on the areas covered by the 10-mile boundaries) include printing, publishing, and paper product manufacturing; the airport source category, which includes airports and related operations as well as small runways and heliports, such as those associated with hospitals or television stations; metals processing and fabrication; and ship/boat manufacturing or repair. The emissions source closest to AZFL is a plastic, resin, or rubber products plant, and is the only source within 2 miles of the site. While the emissions source closest to SKFL falls into the miscellaneous commercial/industrial facility source category, a plastic, resin, or rubber products plant, two metals processing/fabrication facilities, two ship/boat manufacturing or repair facilities, an industrial machinery or equipment plant, and two additional miscellaneous facilities are also located within 2 miles of SKFL; many of these facilities are in the cluster of sources to the northwest of SKFL.

SYFL is located in Valrico, which is also part of the Tampa-St. Petersburg-Clearwater, Florida CBSA, although it is on the eastern outskirts of the area. The SYFL monitoring site is located in a rural area, although, as Figure 9-4 shows, a residential community and country club lie just to the west of the site. Located to the south of the site (and shown in the bottom-center

portion of Figure 9-4) are tanks that are part of the local water treatment facility. This site serves as a background site, although the effects of increased development in the area are likely being captured by the monitoring site. This site is the Tampa NATTS site.

Figure 9-5 shows that most of the emissions sources surrounding SYFL are greater than 5 miles away from the site. The point sources shown are included in a variety of sources categories. The airport source category and metals processing and fabrication are among the source categories with the greatest number of emissions sources near SYFL. The closest source to SYFL with reportable air emissions in the 2014 NEI is a food processing facility.

ORFL is located in Winter Park, north of Orlando. Figure 9-6 shows that ORFL is located near Lake Mendsen, just behind Community Playground. The site is east of Lake Killarney and south of Winter Park Village. This site lies in a commercial area and is a population exposure site.

PAFL is located in northeast Orlando, on the northwestern edge of the Orlando Executive Airport property, as shown in Figure 9-7. The area is commercial in nature and experiences heavy traffic. The airport is bordered by Colonial Drive to the north and the East-West Expressway (Toll Road 408) to the south (although not shown in Figure 9-7). A large shopping complex is located to the northeast of the site, just north of the airport, between Colonial Drive and Maguire Boulevard. Interstate-4 runs north-south approximately 2 miles to the west of the monitoring site.

ORFL is located 3.3 miles north-northwest of PAFL. Most of the point sources surrounding these sites are located on the western side of the 10-mile boundaries, as shown in Figure 9-8. Although the emissions sources surrounding ORFL and PAFL are involved in a variety of industries and processes, the airport and airport support operations source category has the greatest number of emissions sources within 10 miles of these sites. The closest emissions source to PAFL is Orlando Executive Airport, which is located under the star symbol for PAFL in Figure 9-8. The closest emissions sources to ORFL are located to the south of the site: a hospital, which falls into the institutions category, and the heliport located at the hospital, which falls into the airport source category.

In addition to providing city, county, CBSA, and land use/location setting information, Table 9-1 also contains traffic volume information for each site as well as the location for which the traffic volume was obtained. This information is provided because emissions from motor

vehicles can significantly affect concentrations measured at a given monitoring site. The traffic volumes in Table 9-1 are higher near the Orlando sites than the Tampa/St. Petersburg sites. Different traffic locations for AZFL and SKFL were chosen for this NMP report compared to previous reports. The traffic volume for PAFL ranks 20th highest among other NMP sites, with ORFL ranking 24th. The traffic volumes near AZFL, SKFL, and SYFL are in the bottom third compared to other NMP sites.

9.2 Pollutants of Interest

The risk-based screening process described in Section 3.2 was performed for each site to identify site-specific "pollutants of interest," which allows analysts and readers to focus on a subset of pollutants through the context of risk. For each site, each pollutant's preprocessed daily measurement was compared to its associated risk screening value. If the concentration was greater than the risk screening value, then the concentration "failed the screen." The site-specific results of this risk-based screening process are presented in Table 9-2 and incorporate measurements from both 2015 and 2016. Pollutants of interest are those for which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens and are shaded in gray in Table 9-2. It is important to note which pollutants were sampled for at each site when reviewing the results of this analysis. Carbonyl compounds were sampled for at AZFL, SYFL, and ORFL. PAHs were sampled for in addition to carbonyl compounds at SKFL. PM_{10} metals were sampled for at PAFL.

Observations from Table 9-2 include the following:

- For AZFL, SYFL, and ORFL, the sites sampling only carbonyl compounds, acetaldehyde and formaldehyde were the only two pollutants to fail screens. Among the carbonyl compounds, only acetaldehyde, formaldehyde, and propionaldehyde have risk screening values. Propionaldehyde did not fail any screens for these three sites.

- For SYFL, formaldehyde and acetaldehyde failed the same number of screens and contributed equally to the total number of failed screens. For AZFL and ORFL, concentrations of acetaldehyde failed a few less screens than formaldehyde. For all three sites, formaldehyde failed 100 percent of screens.

- Concentrations of five pollutants failed at least one screen for SKFL (two carbonyl compounds and three PAHs). Acetaldehyde and formaldehyde failed the most screens, followed by naphthalene. Together, these three pollutants account for 99 percent of failed screens for SKFL, and thus were identified as pollutants of interest for this site.

- Arsenic and nickel are the only PM_{10} metals to fail screens for PAFL, with arsenic accounting for just less than 95 percent of the failed screens. Thus, both arsenic and nickel are pollutants of interest for PAFL.

Table 9-2. 2015-2016 Risk-Based Screening Results for the Florida Monitoring Sites

Pollutant	Screening Value ($\mu g/m^3$)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
St. Petersburg, Florida – AZFL						
Formaldehyde	0.077	119	119	100.00	51.52	51.52
Acetaldehyde	0.45	112	119	94.12	48.48	100.00
Total		231	238	97.06		
Pinellas Park, Florida – SKFL						
Formaldehyde	0.077	117	117	100.00	37.03	37.03
Acetaldehyde	0.45	116	117	99.15	36.71	73.73
Naphthalene	0.029	80	118	67.80	25.32	99.05
Fluorene	0.011	2	95	2.11	0.63	99.68
Acenaphthene	0.011	1	110	0.91	0.32	100.00
Total		316	557	56.73		
Valrico, Florida – SYFL						
Acetaldehyde	0.45	113	113	100.00	50.00	50.00
Formaldehyde	0.077	113	113	100.00	50.00	100.00
Total		226	226	100.00		
Winter Park, Florida – ORFL						
Formaldehyde	0.077	99	99	100.00	50.51	50.51
Acetaldehyde	0.45	97	99	97.98	49.49	100.00
Total		196	198	98.99		
Orlando, Florida – PAFL						
Arsenic (PM_{10})	0.00023	52	53	98.11	94.55	94.55
Nickel (PM_{10})	0.0021	3	54	5.56	5.45	100.00
Total		55	107	51.40		

For each of the data analyses described in the remaining sections, the focus is on the site-specific pollutants of interest identified via the risk-based screening process, as described in Section 3.4.2.

9.3 Concentrations

This section presents various concentration averages used to characterize air toxics concentration levels at the Florida monitoring sites. Where applicable, the following calculations and data analyses were performed for each of the site-specific pollutants of interest:

- Time period-based concentration averages (quarterly and annual) are provided for each monitoring site for each year.
- The range of measurements and annual average concentrations are presented graphically for each site to illustrate how the site's concentrations compare to the program-level averages, as presented in Section 4.1.
- Concentration averages and other statistical metrics for 2015, 2016, and from previous years of monitoring are presented in order to characterize concentration trends at each site.

Each data analysis is performed where the applicable criteria are met (as specified in the appropriate sections below) and is limited to the site-specific pollutants of interest. However, site-specific statistical summaries for all pollutants sampled for at the Florida monitoring sites are provided in Appendices M, N, and O.

9.3.1 2015 and 2016 Concentration Averages

Quarterly and annual concentration averages for 2015 and 2016 were calculated for the pollutants of interest for each Florida monitoring site, as described in Section 3.1. The *quarterly average concentration* of a particular pollutant is simply the average concentration of the preprocessed daily measurements over a given calendar quarter. Quarterly average concentrations include the substitution of zeros for all non-detects. A site must have a minimum of 75 percent valid samples compared to the total number of samples possible within a given calendar quarter for a quarterly average to be calculated. An *annual average concentration* includes all measured detections and substituted zeros for non-detects for an entire year of sampling. Annual averages were calculated for pollutants where three valid quarterly averages could be calculated for a given year and where method completeness was greater than or equal to 85 percent, as presented in Section 2.4. Quarterly and annual average concentrations for the pollutants of interest for the Florida monitoring sites are presented in Table 9-3, where applicable. Note that concentrations of the PAHs and metals for SKFL and PAFL are presented in ng/m^3 for ease of viewing. Also note that if a pollutant was not detected in a given calendar quarter, the quarterly average simply reflects "0" because only zeros substituted for non-detects were factored into the quarterly average concentration.

Table 9-3. Quarterly and Annual Average Concentrations of the Pollutants of Interest for the Florida Monitoring Sites

Pollutant	2015						2016					
	# of Detects/ # >MDL/ # Samples	Q1 Avg (µg/m³)	Q2 Avg (µg/m³)	Q3 Avg (µg/m³)	Q4 Avg (µg/m³)	Annual Average (µg/m³)	# of Detects/ # >MDL/ # Samples	Q1 Avg (µg/m³)	Q2 Avg (µg/m³)	Q3 Avg (µg/m³)	Q4 Avg (µg/m³)	Annual Average (µg/m³)
St. Petersburg, Florida – AZFL												
Acetaldehyde	58/58/58	0.99 ± 0.19	0.71 ± 0.09	NA	0.78 ± 0.16	0.80 ± 0.09	61/61/61	1.17 ± 0.28	1.56 ± 0.41	1.58 ± 0.24	1.35 ± 0.68	1.41 ± 0.21
Formaldehyde	58/58/58	1.52 ± 0.26	2.00 ± 0.28	NA	1.77 ± 0.37	1.79 ± 0.18	61/61/61	1.96 ± 0.33	10.81 ± 5.01	13.30 ± 2.55	3.53 ± 2.15	7.31 ± 1.85
Pinellas Park, Florida – SKFL												
Acetaldehyde	58/58/58	1.28 ± 0.22	1.25 ± 0.13	1.11 ± 0.26	1.09 ± 0.13	1.19 ± 0.09	59/59/59	1.30 ± 0.27	1.14 ± 0.12	1.01 ± 0.16	1.39 ± 0.28	1.21 ± 0.11
Formaldehyde	58/58/58	1.80 ± 0.34	3.18 ± 0.54	2.63 ± 0.72	5.90 ± 1.32	3.39 ± 0.56	59/59/59	3.41 ± 2.31	3.46 ± 0.97	3.66 ± 0.62	8.61 ± 4.37	4.72 ± 1.29
Naphthalene[a]	59/59/59	41.13 ± 13.52	32.49 ± 5.51	39.01 ± 7.58	33.01 ± 6.35	36.05 ± 3.91	59/59/59	59.45 ± 25.06	49.89 ± 14.32	45.02 ± 10.76	41.98 ± 7.34	49.34 ± 7.81
Valrico, Florida – SYFL												
Acetaldehyde	57/57/57	1.36 ± 0.29	1.39 ± 0.22	1.31 ± 0.19	0.66 ± 0.11	1.19 ± 0.13	56/56/56	1.11 ± 0.21	1.14 ± 0.12	NA	1.02 ± 0.15	1.04 ± 0.09
Formaldehyde	57/57/57	1.58 ± 0.41	3.08 ± 0.45	3.35 ± 1.09	1.41 ± 0.24	2.37 ± 0.37	56/56/56	2.09 ± 0.68	2.97 ± 0.40	NA	1.94 ± 0.24	2.28 ± 0.25
Winter Park, Florida – ORFL												
Acetaldehyde	58/58/58	2.21 ± 0.36	1.26 ± 0.21	1.43 ± 0.21	0.96 ± 0.21	1.45 ± 0.17	41/41/41	1.53 ± 0.30	1.29 ± 0.17	1.25 ± 0.21	NS	1.36 ± 0.14
Formaldehyde	58/58/58	1.82 ± 0.92	3.00 ± 0.47	3.01 ± 0.39	1.74 ± 0.41	2.37 ± 0.32	41/41/41	1.95 ± 0.35	3.08 ± 0.44	3.20 ± 0.57	NS	2.71 ± 0.31
Orlando, Florida – PAFL												
Arsenic (PM_{10})[a]	29/29/30	0.43 ± 0.24	0.44 ± 0.24	1.03 ± 0.56	0.54 ± 0.10	0.62 ± 0.18	24/23/24	0.56 ± 0.18	0.49 ± 0.15	0.51 ± 0.30	NS	0.52 ± 0.12
Nickel (PM_{10})[a]	30/28/30	4.00 ± 4.97	0.59 ± 0.24	0.54 ± 0.22	0.46 ± 0.16	1.34 ± 1.14	24/23/24	0.52 ± 0.16	2.81 ± 4.69	0.75 ± 0.33	NS	1.36 ± 1.47

[a] Average concentrations provided below the blue line for this site and/or pollutant are presented in ng/m³ for ease of viewing.
NA = Not available because the criteria for calculating a quarterly and/or annual average were not met.
NS = Sampling was not conducted during this time.

Observations for AZFL from Table 9-3 include the following:

- Both acetaldehyde and formaldehyde were detected in every valid sample collected at AZFL.

- Quarterly average concentrations are not presented for the third quarter of 2015 due to one too many invalid samples.

- Concentrations of acetaldehyde measured at AZFL range from 0.168 µg/m^3 to 5.72 µg/m^3. Both of these concentrations were measured during the fourth quarter of 2016, explaining, at least in part, the relatively large confidence interval associated with this quarterly average. The quarterly average concentrations of acetaldehyde for 2016 are greater than the quarterly averages for 2015; none of the quarterly averages for 2015 are greater than 1 µg/m^3 while all of them for 2016 are. Further, the annual average for 2016 (1.41 ± 0.21 µg/m^3) is significantly higher than the annual average for 2015 (0.80 ± 0.09 µg/m^3). A review of the acetaldehyde data collected at AZFL shows that all but two of the 25 acetaldehyde concentrations greater than 1.5 µg/m^3 were measured during 2016. The difference between the two year's measurements is even more pronounced in the formaldehyde data.

- Concentrations of formaldehyde measured at AZFL range from 0.341 µg/m^3 to 22.2 µg/m^3. Although not the maximum concentration measured across the program during the 2015 and 2016 monitoring efforts, the maximum formaldehyde concentration measured at AZFL ranks third highest. Concentrations of formaldehyde measured at AZFL account for half of the 30 measurements greater than 15 µg/m^3. Based on the quarterly averages in Table 9-3, a significant increase in the magnitude of formaldehyde concentrations occurs during the second quarter of 2016. The second quarter average concentration for 2016 (10.81 ± 5.01 µg/m^3) is more than five times the previous quarterly averages. The concentrations remain elevated through the third quarter, but decrease somewhat for the fourth quarter. Between May 24, 2016 and October 15, 2016, all but two of the 26 formaldehyde measurements are greater than 10 µg/m^3. A new collection system was installed on October 27, 2016. If the concentrations from the first three sample days in October 2016 were excluded from the quarterly average, the fourth quarter average would decrease by more than half.

Observations for SKFL from Table 9-3 include the following:

- Acetaldehyde, formaldehyde, and naphthalene were detected in every valid sample collected at SKFL.

- Concentrations of acetaldehyde measured at SKFL range from 0.0542 µg/m^3 to 2.24 µg/m^3. The minimum acetaldehyde concentration measured at SKFL is an order of magnitude less than the next lowest acetaldehyde concentration measured at this site and among only a few less than 0.1 µg/m^3 measured across the program. Less than 0.4 µg/m^3 separates the quarterly average concentrations of acetaldehyde for SKFL and there is little difference between the 2015 (1.19 ± 0.09 µg/m^3) and 2016 (1.21 ± 0.11 µg/m^3) annual average concentrations of acetaldehyde.

- Concentrations of formaldehyde measured at SKFL range from 0.0948 µg/m^3 to 19.1 µg/m^3, with the minimum formaldehyde concentration measured on the same

day as the minimum acetaldehyde concentration (September 27, 2016). For 2015, quarterly average concentrations are highly variable, with the highest quarterly average concentration (fourth quarter, 5.90 ± 1.32 µg/m^3) three times higher than the lowest quarterly average concentration (first quarter, 1.80 ± 0.34 µg/m^3). For 2015, 10 of the 11 formaldehyde concentrations greater than 6 µg/m^3 were measured between late October and the end of the year. For 2016, most of the higher formaldehyde concentrations were also measured during the fourth quarter of the year. Six of the seven formaldehyde concentrations greater than 10 µg/m^3 were measured in November or December 2016. All seven formaldehyde concentrations greater than 10 µg/m^3 measured at SKFL were measured in 2016, one in February and the other six in November or December. The variability in the formaldehyde concentrations measured is reflected the confidence intervals shown, particularly for the first and fourth quarters of 2016. This can also be seen in the annual averages.

- Concentrations of naphthalene measured at SKFL range from 10.7 ng/m^3 to 190 ng/m^3. The 2016 annual average naphthalene concentration is significantly higher than the 2015 annual average concentration; the quarterly average concentrations for these years reflect this as well. All four naphthalene concentrations greater than 100 ng/m^3 were measured in 2016, three during the first quarter and one during the second; further, 15 of the 16 highest naphthalene concentrations measured at SKFL (those greater than 70 ng/m^3) were measured in 2016. The quarterly average naphthalene concentrations reflect considerable variability, as indicated in the confidence intervals, particularly those for the first quarter of 2015, and most of those for 2016.

Observations for SYFL from Table 9-3 include the following:

- Acetaldehyde and formaldehyde were detected in every valid sample collected at SYFL.

- Concentrations of acetaldehyde measured at SYFL range from 0.468 µg/m^3 to 2.44 µg/m^3. For 2015, the first three quarterly average concentrations of acetaldehyde are similar to each other, but the fourth quarter average is significantly lower than the others; this quarterly average is also significantly lower than the available quarterly averages for 2016. Twelve (of the 13) acetaldehyde concentrations measured during the fourth quarter of 2015 are less than 1 µg/m^3; between two (third quarter) and four (first quarter) acetaldehyde concentrations less than 1 µg/m^3 were measured during the other calendar quarters for 2015. For 2016, the available quarterly average concentrations are fairly similar to each other. Excluding the fourth quarter average for 2015, the quarterly averages and annual average for 2016 are slightly lower than those calculated for 2015, although the differences are not statistically significant.

- Concentrations of formaldehyde measured at SYFL range from 0.769 µg/m^3 to 9.70 µg/m^3. For 2015, the second and third quarter average concentrations of formaldehyde are significantly higher than the first and fourth quarter averages. All but one of the 16 formaldehyde concentrations greater than 3 µg/m^3 measured in 2015 were measured between April and September, including the maximum concentration, which is considerably higher than the next highest concentration measured at SYFL (5.51 µg/m^3). Fewer concentrations greater than 3 µg/m^3 were measured at SYFL in

2016 (seven), with most (four) of these measured during the second quarter of 2016. Similar to acetaldehyde, the annual average concentration of formaldehyde for 2016 is slightly lower than the annual average calculated for 2015, although the difference is not statistically significant.

- Quarterly average concentrations for the third quarter of 2016 could not be calculated due to a series of invalid samples at the end of July and beginning of August 2016.

Observations for ORFL from Table 9-3 include the following:

- Acetaldehyde and formaldehyde were detected in every valid sample collected at ORFL.

- Concentrations of acetaldehyde measured at ORFL span an order of magnitude, ranging from 0.356 $\mu g/m^3$ to 3.72 $\mu g/m^3$. The four highest acetaldehyde concentrations measured at ORFL, those greater than 2.75 $\mu g/m^3$, were all measured in January, with three in 2015 and one in 2016. Twelve of the 15 acetaldehyde concentrations greater than 2 $\mu g/m^3$ were measured during the first quarter of either year, with nine measured during the first quarter of 2015 and three measured during the first quarter of 2016. This is reflected in the quarterly averages shown for the first quarter, particularly for 2015. The annual average concentrations of acetaldehyde for ORFL vary by less than 0.1 $\mu g/m^3$.

- Concentrations of formaldehyde measured at ORFL range from 0.582 $\mu g/m^3$ to 7.43 $\mu g/m^3$. For 2015, the first and fourth quarter average concentrations are less than the second and third quarter averages, although the confidence interval for the first quarter is more than twice the magnitude of the other confidence intervals. All seven formaldehyde concentrations less than 1 $\mu g/m^3$ measured over the 2 years of sampling were measured during either the first (4) or fourth (3) quarters of 2015. The maximum formaldehyde concentration was also measured during the first quarter of 2015; the combination of the lower concentrations and the maximum concentration explains the relatively large confidence interval shown for the first quarter of 2015.

- Carbonyl compound sampling at ORFL was discontinued after the third quarter of 2016.

Observations for PAFL from Table 9-3 include the following:

- PAFL is the only Florida monitoring site that did not sample carbonyl compounds.

- PM_{10} metals were sampled for at PAFL on a 1-in-12 day schedule, while the other Florida sites sampled on a 1-in-6 day schedule, thus, yielding roughly half the number of samples as the remaining sites. Sampling at PAFL was discontinued after the third quarter of 2016.

- Concentrations of arsenic measured at PAFL range from 0.019 ng/m^3 to 2.77 ng/m^3. With the exception of the third quarter of 2015, the quarterly average concentrations of arsenic do not vary considerably; the third quarter average for 2015 is roughly twice the other quarterly averages shown in Table 9-3. A review of the data shows that the maximum arsenic concentration measured at PAFL was measured during this

calendar quarter (on August 22, 2015). The third quarter of 2015 is the only calendar quarter in which more than one arsenic concentration greater than 1 ng/m^3 was measured at PAFL.

- Concentrations of nickel measured at PAFL span two orders of magnitude, ranging 0.170 ng/m^3 to 18.0 ng/m^3, including three nickel measurements greater than 10 ng/m^3 (the most of any NMP site). The first quarter average for 2015 and the second quarter average for 2016 are considerably higher than the other quarterly averages, each with a confidence interval greater than the average itself. Two relatively high nickel concentrations (14.2 ng/m^3 and 11.2 ng/m^3) were measured during the first quarter of 2015, and another was measured during the second quarter of 2016 (18.0 ng/m^3). The next highest nickel concentration measured at PAFL is an order of magnitude less. The effects of these higher measurements are also reflected in the annual averages for each year, with confidence intervals similar or greater in magnitude than the averages themselves.

Tables 4-10 through 4-13 present the NMP sites with the 10 highest annual average concentrations for each of the program-level pollutants of interest. Observations for the Florida sites from those tables include the following:

- None of the Florida monitoring sites appear in Table 4-11 for acetaldehyde. Among the Florida sites, annual averages of acetaldehyde range from 0.80 ± 0.09 µg/m^3 (AZFL, 2015) to 1.45 ± 0.17 µg/m^3 (ORFL, 2015).

- AZFL annual average concentration for 2016 is the second highest annual average of formaldehyde among NMP sites sampling carbonyl compounds; SKFL's annual average for 2016 ranks fifth highest. Interestingly, AZFL has both the lowest and highest annual averages of this pollutant among the Florida sites: 1.79 ± 0.18 µg/m^3 for 2015 and 7.31 ± 1.85 µg/m^3 for 2016.

- SKFL is not among the sites with the highest annual average concentrations of naphthalene among NMP sites sampling this pollutant, as shown in Table 4-12.

- PAFL is not among the sites with the highest annual average concentrations of arsenic among NMP sites sampling this pollutant, as shown in Table 4-13.

9.3.2 Concentration Comparison

In order to better illustrate how each site's annual average concentrations compare to the program-level averages, a site-specific box plot was created for each of the site-specific pollutants of interest, where applicable. Thus, box plots were created for the pollutants listed in Table 9-3 for each of the Florida monitoring sites. Figures 9-9 through 9-13 overlay the sites' minimum, annual average, and maximum concentrations for each year onto the program-level minimum, first quartile, median, average, third quartile, and maximum concentrations, as described in Section 3.4.2.1, and are discussed below. If an annual average concentration could not be calculated, the range of concentrations is still provided in the figures that follow.

Figure 9-9. Program vs. Site-Specific Average Acetaldehyde Concentrations

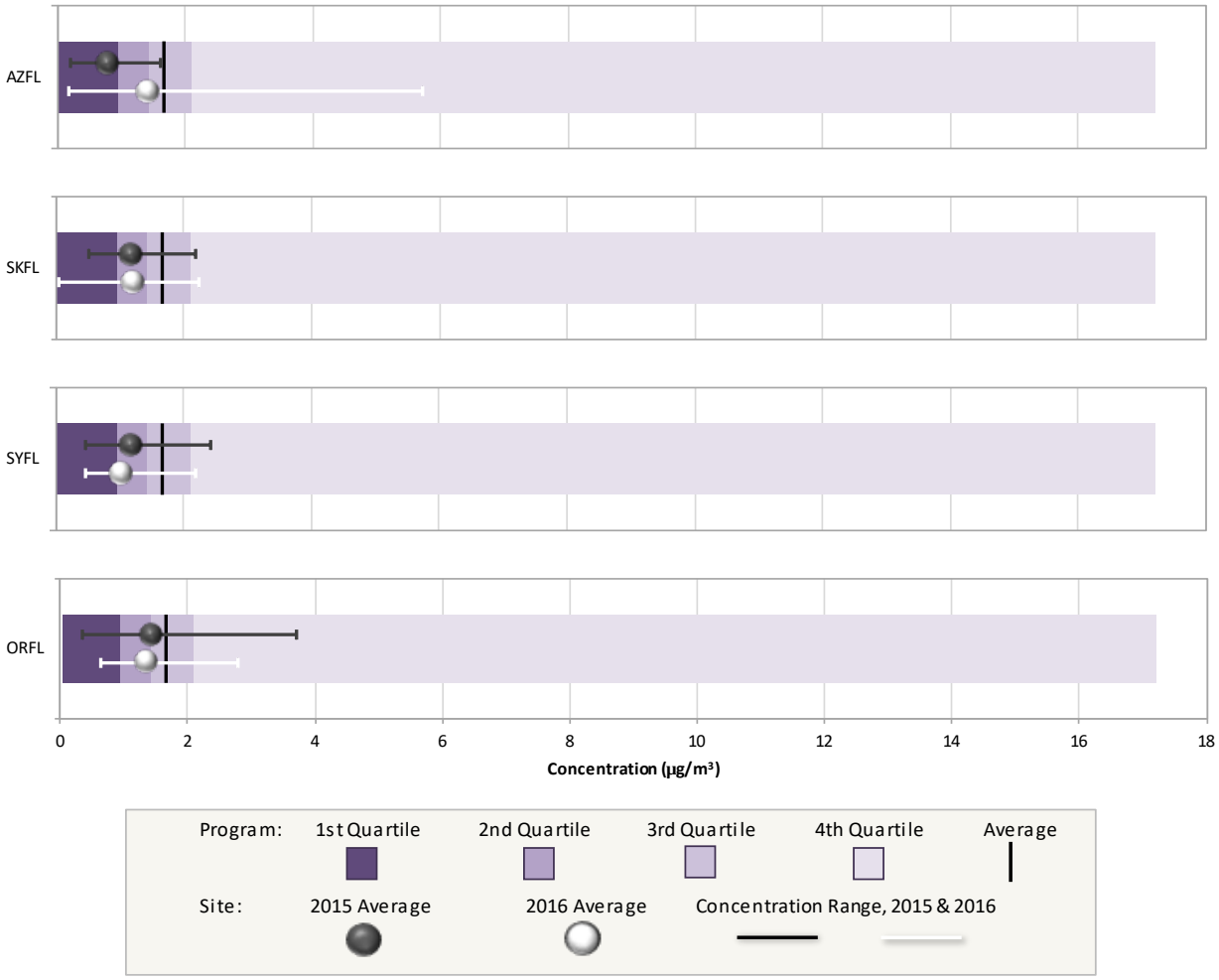


Figure 9-9 presents the box plots for acetaldehyde for the four Florida sites sampling carbonyl compounds and shows the following:

- Among the Florida sites, the maximum acetaldehyde concentration was measured at AZFL (2016), but this measurement is still about one-third the maximum concentration measured across the program.

- All of the annual average concentrations of acetaldehyde for the Florida sites are less than the program-level average concentration of 1.67 µg/m^3.

- The acetaldehyde concentrations measured at AZFL exhibit the largest differences between the two years. For 2015, the entire range of acetaldehyde concentrations measured is less than the program-level average concentration, with an annual average less than the first quartile across the program. For 2016, the range of measurements is much larger, with the annual average similar to the program-level median.

- The minimum acetaldehyde concentration measured at SKFL in 2016 is the minimum concentration measured among the Florida sites. However, if this concentration is

excluded, the range of concentrations measured at SKFL is similar across both years. A similar range of concentrations was measured at SYFL across both years. The annual averages for these two sites fall between the program-level first quartile and median concentrations.

- A slightly larger range of acetaldehyde concentrations was measured at ORFL in 2015 compared to 2016; these years' annual average concentrations fall on either side of the program-level median concentration (1.43 µg/m^3).

Figure 9-10. Program vs. Site-Specific Average Arsenic (PM_{10}) Concentrations

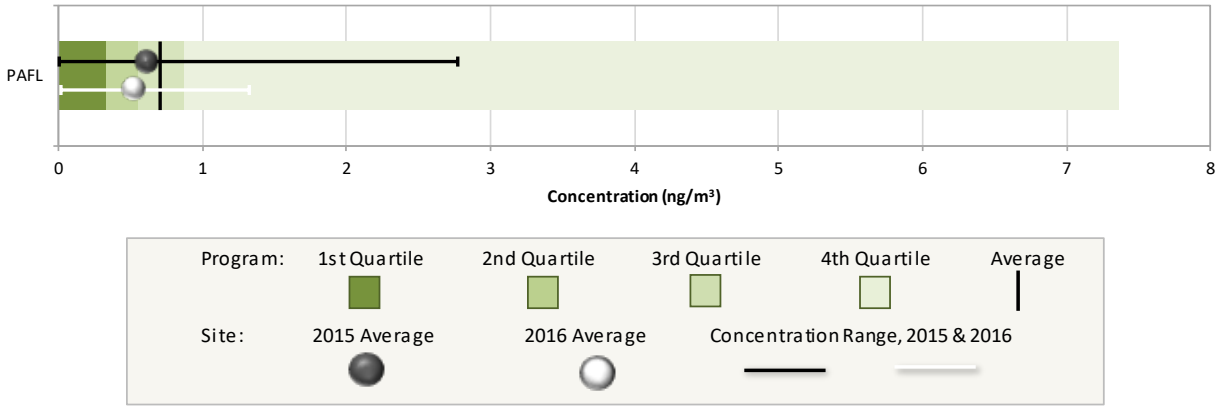


Figure 9-10 presents the box plot for arsenic for PAFL and shows the following:

- The range of arsenic concentrations measured at PAFL in 2015 is approximately twice the range measured in 2016. The maximum concentration measured at PAFL is considerably less than the maximum concentration measured across the program.

- Although the minimum arsenic concentration measured each year at PAFL appears similar, the minimum concentration for 2015 is a non-detect while the minimum concentration for 2016 is 0.019 ng/m^3; the minimum concentration measured at PAFL in 2016 is among one of the lower arsenic concentrations measured across the program.

- Both annual average concentrations of arsenic for PAFL are less than the program-level average concentration of 0.70 ng/m^3. The annual average concentration for 2016 is also just less than the program-level median concentration of 0.55 ng/m^3.

Figure 9-11. Program vs. Site-Specific Average Formaldehyde Concentrations

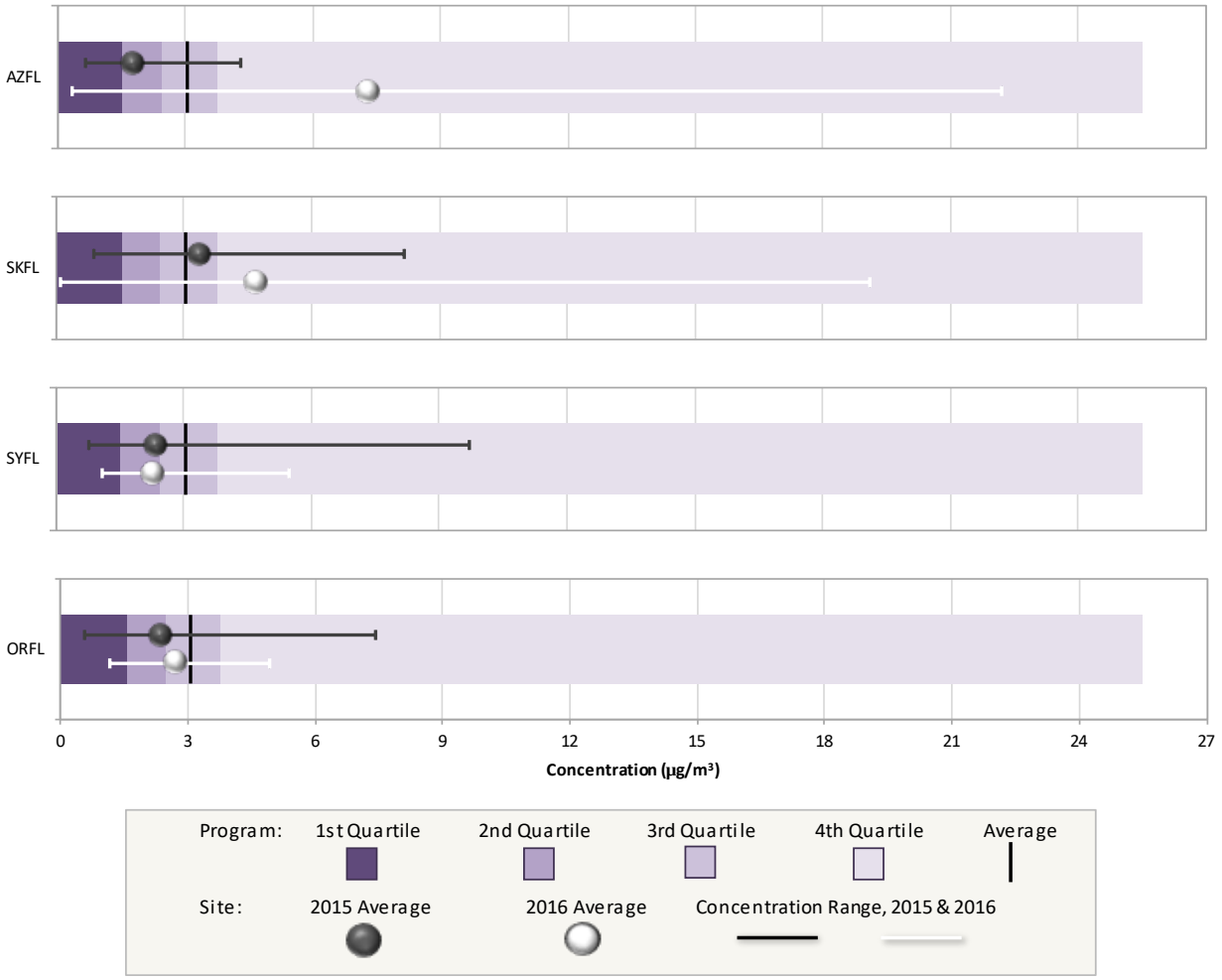


Figure 9-11 presents the box plots for the four Florida sites sampling carbonyl compounds and shows the following:

- While the maximum formaldehyde concentrations measured at AZFL and SKFL in 2016 are considerably higher than the maximum concentrations measured at the other Florida sites, they are still not the highest concentrations measured across the program (two concentrations greater than 25 µg/m^3 were measured at BTUT).

- AZFL has the largest disparity in the formaldehyde concentrations measured between the two years of sampling. The annual average concentration for 2016 is more than four times greater than the annual average for 2015. The annual average formaldehyde concentration for AZFL for 2015 is just greater than the program-level first quartile, while the annual average for 2016 is nearly twice the program-level third quartile.

- Formaldehyde concentrations measured at SKFL also vary considerably between 2015 and 2016. While more than 1 µg/m^3 separates this site's annual averages, both are greater than the program-level average concentration of 3.05 µg/m^3.

- For SYFL and ORFL, the range of formaldehyde concentrations measured in 2015 is greater than the range measured in 2016. SYFL's annual average concentrations of formaldehyde are both just less than the program-level median concentration. Despite the larger range of concentrations measure at ORFL in 2015, the annual average for 2015 is less than the annual average for 2016, with both less than the program-level average concentration.

Figure 9-12. Program vs. Site-Specific Average Naphthalene Concentrations

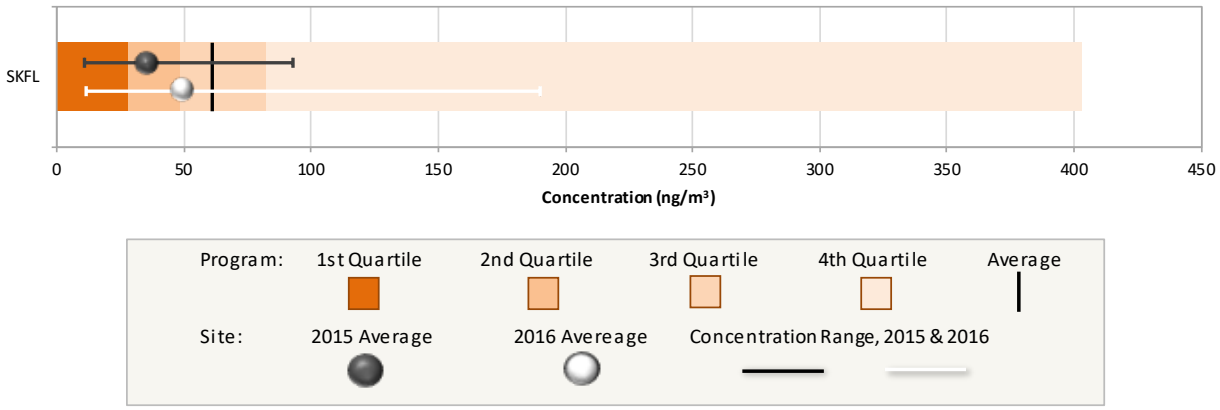


Figure 9-12 presents the box plot for naphthalene for SKFL and shows the following:

- The range of naphthalene concentrations measured at SKFL in 2016 is more than twice the range measured in 2015. The maximum concentration measured at SKFL across both years of sampling is considerably less than the maximum concentration measured across the program (403 ng/m^3).

- Both annual average concentrations of naphthalene for SKFL are less than the program-level average concentration (61.2 ng/m^3); the annual average for 2016 is similar to the program-level median concentration (48.9 ng/m^3), while the annual average for 2015 falls between the program-level first quartile and median concentration.

Figure 9-13. Program vs. Site-Specific Average Nickel (PM_{10}) Concentrations

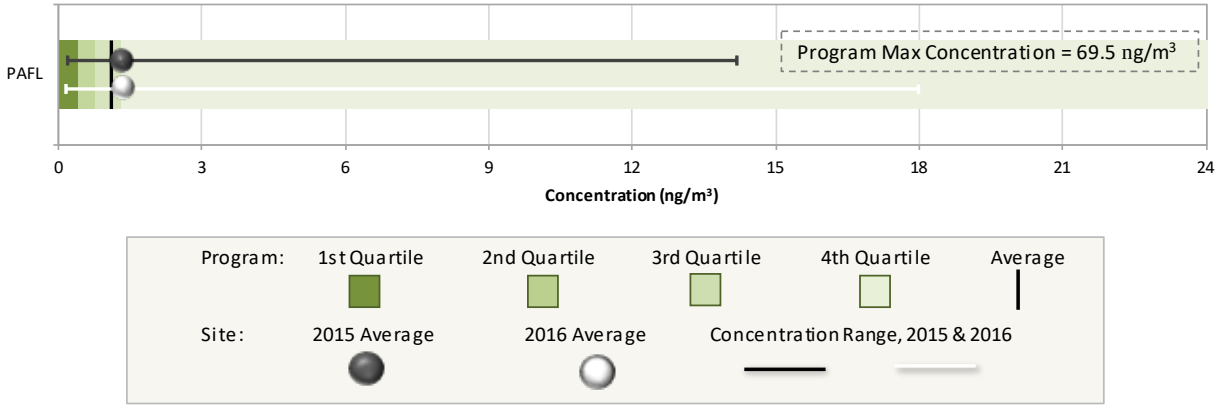


Figure 9-13 presents the box plot for nickel for PAFL and shows the following:

- The program-level maximum nickel (PM_{10}) concentration (69.5 ng/m^3) is not shown directly on the box plot in Figure 9-13 because the scale of the box plot would be too large to readily observe data points at the lower end of the concentration range. Thus, the scale of the box plot has been reduced to 24 ng/m^3.

- The maximum nickel concentration measured at PAFL in 2016 (18.0 ng/m^3) is somewhat higher than the maximum concentration measured in 2015 (14.2 ng/m^3).

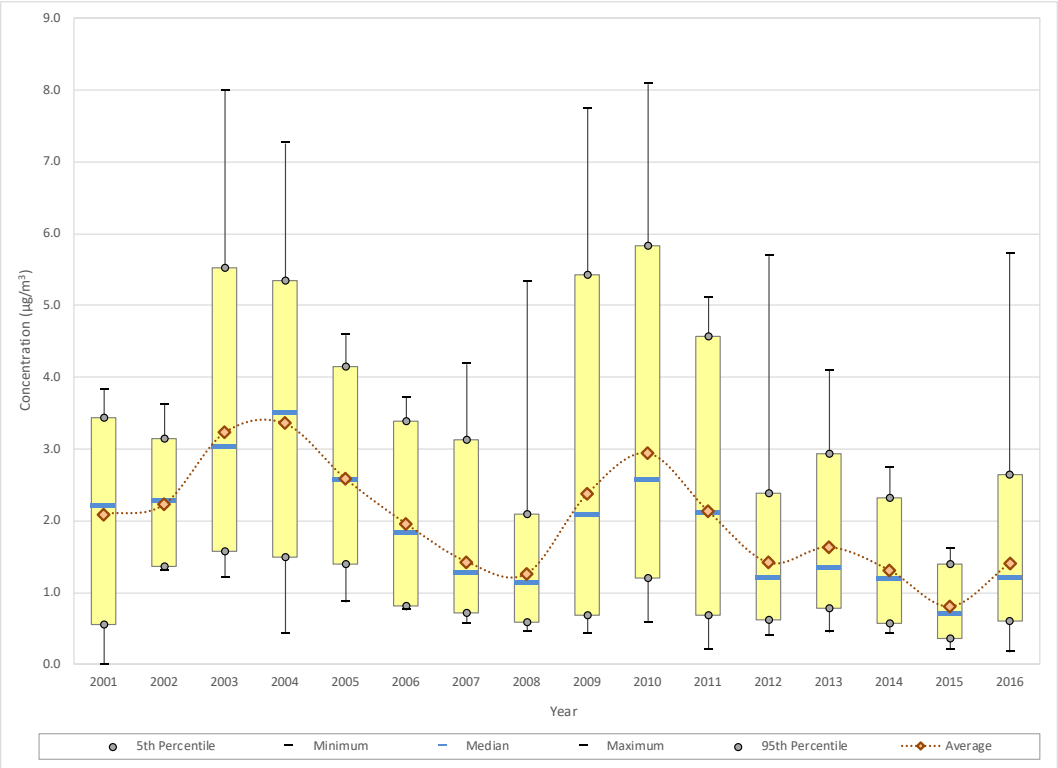
- The annual average nickel concentrations for PAFL are similar to each other, both of which are greater than the program-level average concentration and third quartile.

- Non-detects of nickel were not measured at PAFL.

9.3.3 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the pollutants of interest for 5 consecutive years or longer, as described in Section 3.4.2.2. AZFL, ORFL, SKFL, and SYFL have sampled carbonyl compounds under the NMP for at least 5 consecutive years; in addition, sampling for PAHs at SKFL and PM_{10} metals at PAFL began in 2008. Thus, Figures 9-14 through 9-24 present the 1-year statistical metrics for each of the pollutants of interest for the Florida monitoring sites. The statistical metrics presented for assessing trends include the substitution of zeros for non-detects. If sampling began or ended mid-year, a minimum of 6 months of sampling is required for inclusion in the trends analysis; in these cases, a 1-year average concentration is not provided, although the range and percentiles are still presented.

Figure 9-14. Yearly Statistical Metrics for Acetaldehyde Concentrations Measured at AZFL



Observations from Figure 9-14 for acetaldehyde concentrations measured at AZFL include the following:

- Carbonyl compounds have been measured at AZFL under the NMP since 2001, making this site one of the longest running NMP sites.

- The maximum acetaldehyde concentration was measured in 2010 (8.09 µg/m^3), although similar concentrations were also measured in 2003 (8.00 µg/m^3) and 2009 (7.74 µg/m^3).

- The 1-year average and median concentrations did not change significantly during the first 2 years of sampling, although the range of measurements is twice as large for 2001 compared to 2002. The 1-year average and median concentrations increased significantly from 2002 to 2003, remained elevated through 2004, then began decreasing significantly, a trend that continued through 2008.

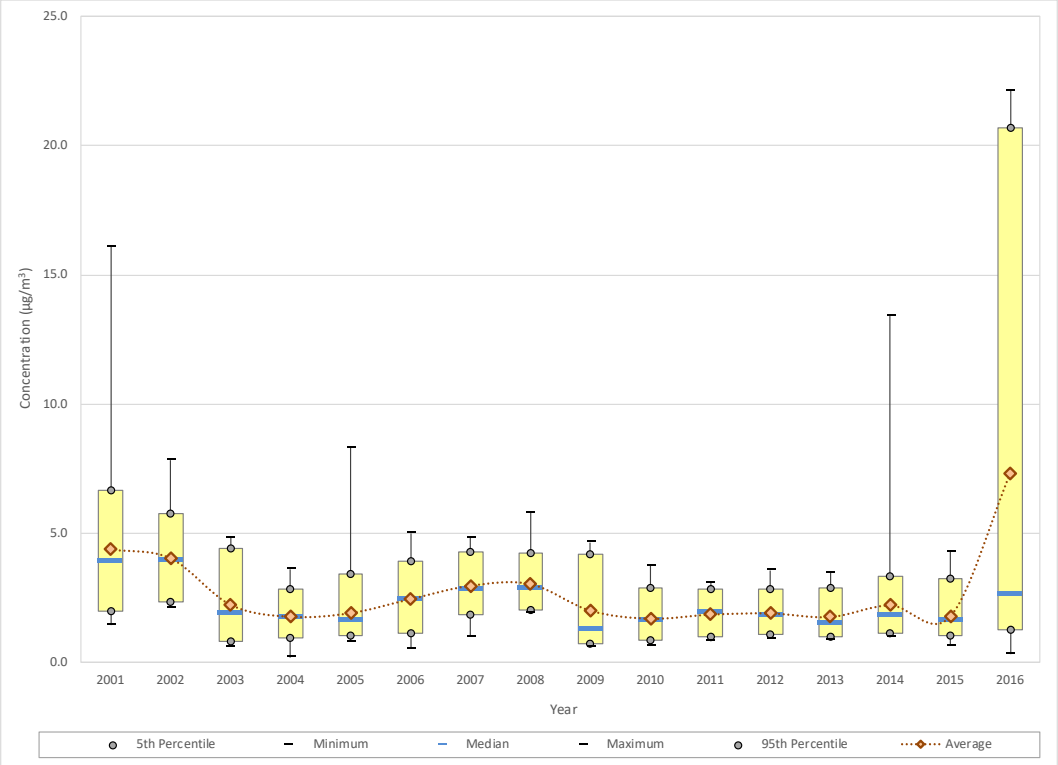
- The 1-year average and median concentrations began to increase again in 2009. Nearly all of the statistical parameters exhibit this increase and the trend continued into 2010. The 95th percentile more than doubled from 2008 to 2009, and the 1-year average and median concentrations exhibit increases slightly less in magnitude.

- A significant decrease is shown for 2011 and continued into 2012, despite the increase in the maximum concentration measured in 2012. Slight increases in the central tendency statistics are shown for 2013, with a return to 2012 levels for 2014.

Additional decreases are shown for 2015, when all of the statistical parameters (except the minimum) are at a minimum over the years of sampling; 2015 is the only year in which both central tendency parameters are less than 1 µg/m^3.

- A significant increase in the 1-year average and median concentrations is shown for 2016, returning to near 2014 levels.

Figure 9-15. Yearly Statistical Metrics for Formaldehyde Concentrations Measured at AZFL



Observations from Figure 9-15 for formaldehyde concentrations measured at AZFL include the following:

- The maximum formaldehyde concentration (22.2 µg/m^3) was measured in 2016, along with three other measurements greater than 20 µg/m^3; the 12 highest formaldehyde concentrations were all measured in 2016. Twenty-five formaldehyde concentrations greater than 10 µg/m^3 have been measured at AZFL, one each in 2001 and 2014, and 23 in 2016.

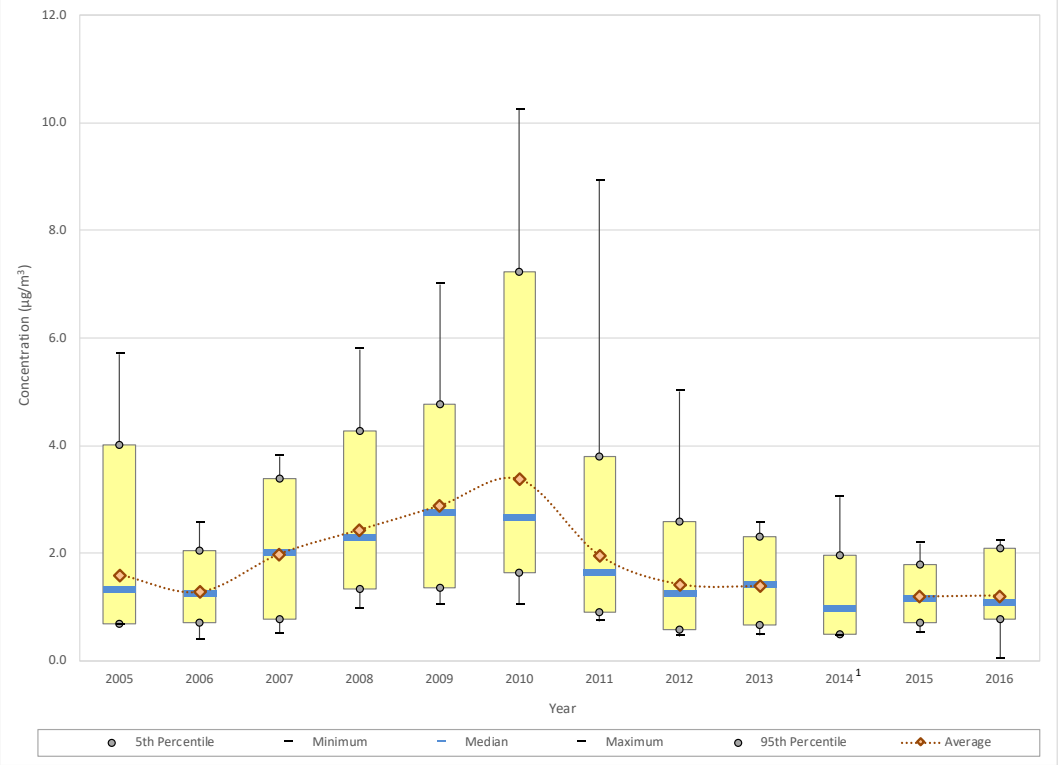
- Slight changes in the 1-year average and median formaldehyde concentrations are shown between 2001 and 2002, despite the difference in the range of concentrations measured. These central tendency parameters decreased significantly from 2002 to 2003. The decreasing trend continued through 2004, after which an increasing trend is shown, which lasted through 2008. A second significant decrease is shown from 2008 to 2009 and into 2010 (although the median concentration increased for 2010). Little change is shown for the next 3 years of sampling.

- Each of the statistical parameters exhibits at least a slight increase from 2013 to 2014, though the increase in the maximum concentration measured in 2014 is the most apparent. If the maximum concentration was removed from the calculation, the 1-year average concentration would decrease only slightly, and the other parameters would change little. Five concentrations measured in 2013 were less than the minimum concentration measured in 2014. On the other end of the concentration range, the number of formaldehyde concentrations greater than 2.5 µg/m^3 doubled from 2013 (8) to 2014 (16). Thus, the slight increases shown for 2014 were not solely attributable to the maximum concentration.

- Even though the majority of concentrations measured in 2015 fell into a similar range as those measured in 2014, as indicated by the 5th and 95th percentiles, both central tendency parameters exhibit slight decreases. This would be true even if the maximum concentration measured in 2014 was excluded from the calculations.

- With the exception of the minimum concentration, all of the statistical parameters exhibit increases for 2016. The maximum concentration and 95th percentile exhibit five- and six-fold increases, respectively, and the 1-year average concentration increased more than four times from 2015 to 2016. As discussed in the previous section, a new collection system was installed at this site in the latter part of 2016, after which higher formaldehyde concentrations were not measured.

Figure 9-16. Yearly Statistical Metrics for Acetaldehyde Concentrations Measured at SKFL



[1] A 1-year average is not presented because some samples collected from July to Sept 2014 were invalidated.

Observations from Figure 9-16 for acetaldehyde concentrations measured at SKFL include the following:

- Sampling for carbonyl compounds under the NMP began at SKFL in late July 2004. Because this represents less than half of the sampling year, Figure 9-16 excludes data from 2004.

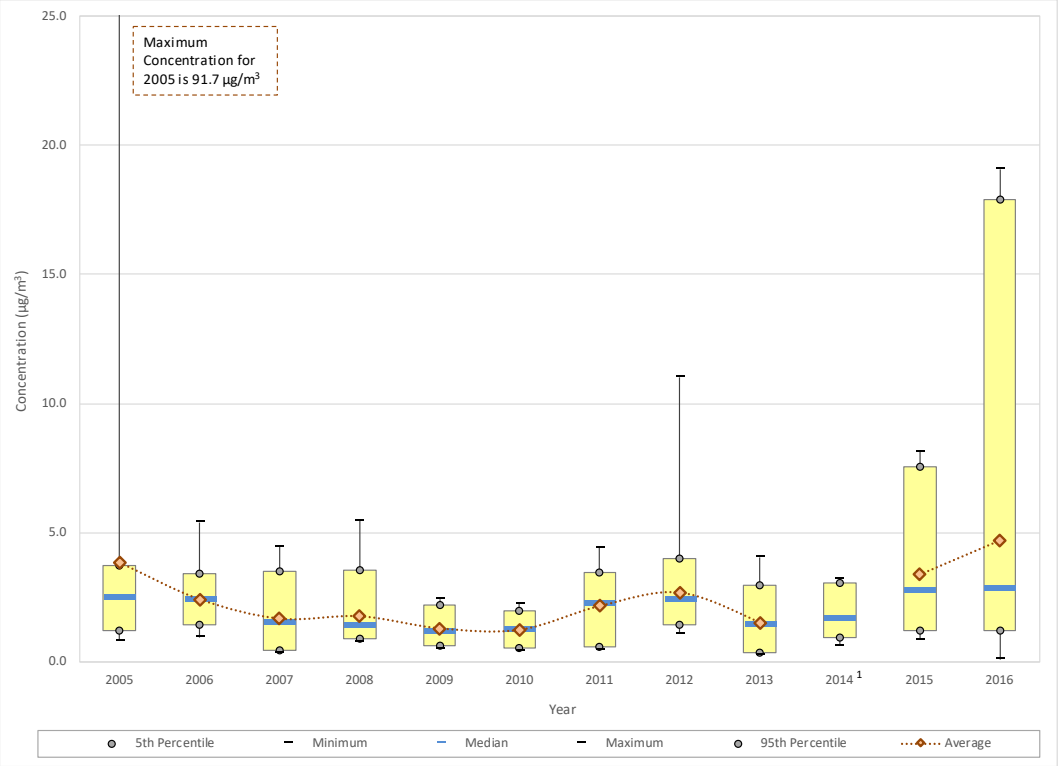
- The maximum acetaldehyde concentration shown was measured at SKFL in 2010 (10.3 µg/m^3), as were the third, fourth, and fifth highest concentrations of acetaldehyde. Of the 18 acetaldehyde concentrations greater than 5 µg/m^3, 11 were measured in 2010.

- Even though the range of concentrations measured decreased by more than half from 2005 to 2006, the change in the 1-year average concentration is not statistically significant. After 2006, the 1-year average acetaldehyde concentration increased steadily each year, reaching a maximum in 2010. Most of the statistical parameters are at a maximum for 2010. A significant decrease is shown for 2011 and continued into 2012. Although the range of concentrations measured decreased by half for 2013, the 1-year average concentration changed little.

- Although an annual average concentration could not be calculated for 2014, the median concentration shown for 2014 is at a minimum for 2014, and is less than 1 µg/m^3 for the first time since the first full year of sampling.

- The smallest range of acetaldehyde concentrations was measured in 2015 and 1-year average concentration is at a minimum over the period of sampling. Little change is shown in this parameter for 2016, although the lowest acetaldehyde concentration measured at SKFL since the onset of sampling was measured in 2016. This measurement is an order of magnitude less than the minimum concentration measured in 2015.

Figure 9-17. Yearly Statistical Metrics for Formaldehyde Concentrations Measured at SKFL



[1] A 1-year average is not presented because some samples collected from July to Sept 2014 were invalidated.

Observations from Figure 9-17 for formaldehyde concentrations measured at SKFL include the following:

- The maximum formaldehyde concentration was measured at SKFL on July 9, 2005 (91.7 µg/m^3). The next seven highest formaldehyde concentrations were measured at SKFL in 2016, and range from roughly 15 µg/m^3 to 20 µg/m^3. Only one other formaldehyde concentration greater than 10 µg/m^3 has been measured at SKFL (11.0 µg/m^3 in 2012).

- For 2005, the 1-year average concentration is greater than the 95th percentile, reflecting the effect that an outlier can have on statistical measurements. The second highest concentration measured in 2005 was 4.07 µg/m^3.

- The 1-year average concentration exhibits an overall decreasing trend through 2010. The range of measurements is at a minimum for 2010 and the 1-year average and median concentrations are nearly equivalent, reflecting little variability in the measurements.

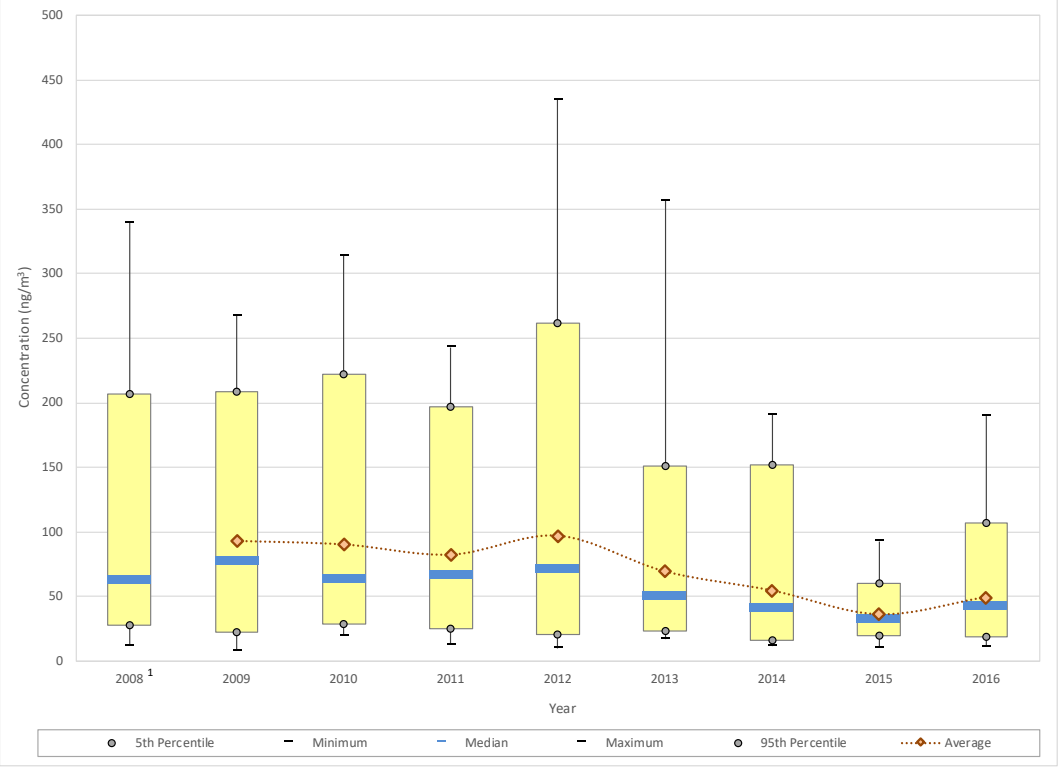
- All of the statistical parameters increased from 2010 to 2011 and again for 2012. The 5th percentile for 2012 is greater than several of the central tendency statistics for several of the previous years.

- All of the statistical parameters exhibit a decrease for 2013, with the concentration profile returning to near 2011 levels.

- Although a 1-year average could not be calculated for 2014, the median concentration exhibits a slight increase for 2014, despite the smaller range of formaldehyde measurements measured in 2014.

- Significant increases are shown for 2015 and 2016, particularly in the statistical metrics representing the upper end of the concentration range. The 1-year average concentration increased three-fold from 2013 to 2016. The median concentration also exhibits an increasing trend between 2013 and 2016, and is at a maximum for 2016.

Figure 9-18. Yearly Statistical Metrics for Naphthalene Concentrations Measured at SKFL



[1] A 1-year average is not presented because sampling under the NMP did not begin until March 2008.

Observations from Figure 9-18 for naphthalene concentrations measured at SKFL include the following:

- Sampling for PAHs began at SKFL under the NMP on March 1, 2008.

- The maximum naphthalene concentration was measured at SKFL in 2012 (435 ng/m^3). Three additional measurements greater than 300 ng/m^3 have been measured at SKFL (one each in 2008, 2010, and 2013).

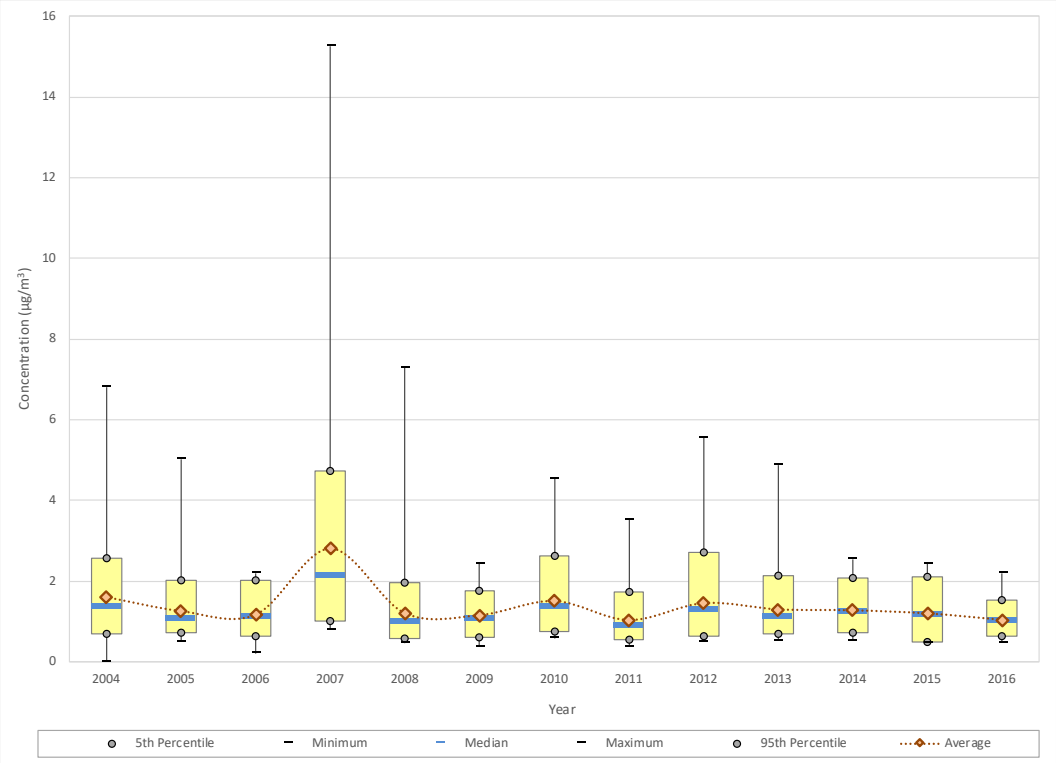
- The range within which the majority of naphthalene concentrations fall changed little through 2011. An increase is shown for 2012 as this year has the greatest number of measurements greater than 200 ng/m^3 (seven). This increase is followed by a

considerable decrease for 2013, which has the fewest measurements greater than 200 ng/m^3 (one) since the onset of sampling PAHs at SKFL.

- A decreasing trend in naphthalene concentrations is shown after 2012, with both the 1-year average and median concentrations at a minimum for 2015. Concentrations of naphthalene greater than 200 ng/m^3 were not measured at SKFL after 2013, and concentrations greater than 100 ng/m^3 were not measured in 2015, the only year for which this is true.

- A significant increase in concentrations is shown for 2016, which has a range of measurements similar to 2014. Although four concentrations measured in 2016 are greater than the maximum concentration measured in 2015, and both the 1-year average and median concentrations increased by at least 10 ng/m^3 from 2015 to 2016, the 1-year average concentration is still less than 50 ng/m^3 for only the second time since the onset of sampling of PAHs at SKFL.

Figure 9-19. Yearly Statistical Metrics for Acetaldehyde Concentrations Measured at SYFL



Observations from Figure 9-19 for acetaldehyde concentrations measured at SYFL include the following:

- Carbonyl compounds have been measured at SYFL under the NMP since January 2004.

- Two acetaldehyde concentrations greater than 10 µg/m^3 were measured at SYFL in January 2007 (15.3 µg/m^3 and 12.6 µg/m^3). The next highest concentration, measured

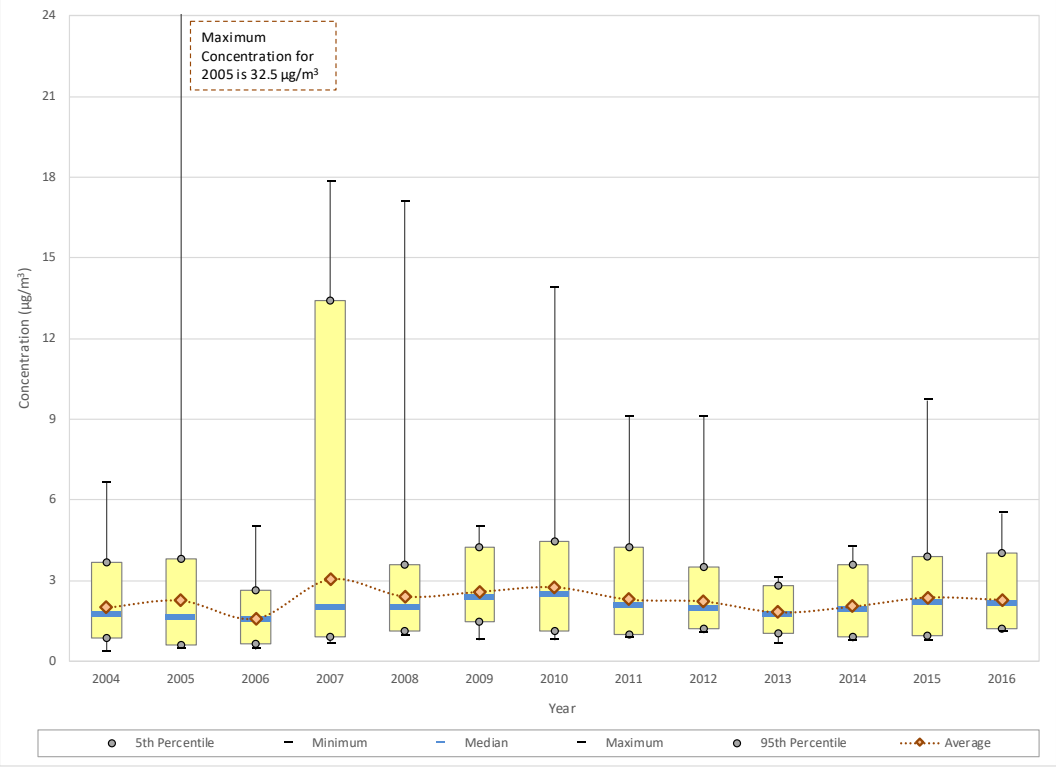
in 2008, is roughly half as high (7.29 µg/m^3). Only one additional acetaldehyde concentration greater than 6 µg/m^3 has been measured at SYFL (6.81 µg/m^3 in 2004).

- After a significant decreasing trend through 2006, all of the statistical parameters increased for 2007. Even if the two measurements of acetaldehyde discussed above were removed from the calculation, the 1-year average concentration for 2007 would still be more than 1 µg/m^3 greater than the next highest 1-year average concentration. 2007 has the greatest number of acetaldehyde concentrations greater than 3 µg/m^3 (16), while every other year of sampling has three or less. Thus, it is not just the two highest measurements driving this 1-year average concentration.

- All of the statistical parameters exhibit a decrease from 2007 to 2008; the 1-year average concentration decreased significantly for 2008. Little change is shown in this parameter for 2009, followed by an undulating pattern through 2013 and a steady, albeit slight, decreasing trend through 2016, when the range of acetaldehyde concentrations measured is at a minimum.

- Between 2008 and 2016, the 1-year average concentration has fluctuated between 1 µg/m^3 and 1.5 µg/m^3. With the exception of 2007, less than 0.6 µg/m^3 separates all of the 1-year averages shown over the period of sampling.

Figure 9-20. Yearly Statistical Metrics for Formaldehyde Concentrations Measured at SYFL



Observations from Figure 9-20 for formaldehyde concentrations measured at SYFL include the following:

- The maximum formaldehyde concentration was measured at SYFL in 2005 (32.5 µg/m^3) and is nearly twice the next highest concentrations (17.8 µg/m^3, measured in 2007, and 17.1 µg/m^3, measured in 2008). In all, seven formaldehyde concentrations greater than 10 µg/m^3 have been measured at SYFL, four in 2007 and one each in 2005, 2008, and 2010.

- Even though the maximum concentration was measured in 2005, the second highest concentration measured that year is considerably less (4.17 µg/m^3). The 1-year average concentration exhibits a slight increase from 2004 to 2005 while the median concentration decreased slightly; if the outlier was excluded from the calculation, the 1-year average concentration would exhibit a decrease for 2005 while the median would change little.

- The slight decrease in most of the statistical parameters for 2006 is followed by large increases for 2007. In particular, the 95th percentile increased five-fold and the 1-year average doubled from 2006 to 2007. As discussed in the previous bullet, 2007 is the only year in which multiple formaldehyde concentrations greater than 10 µg/m^3 were measured.

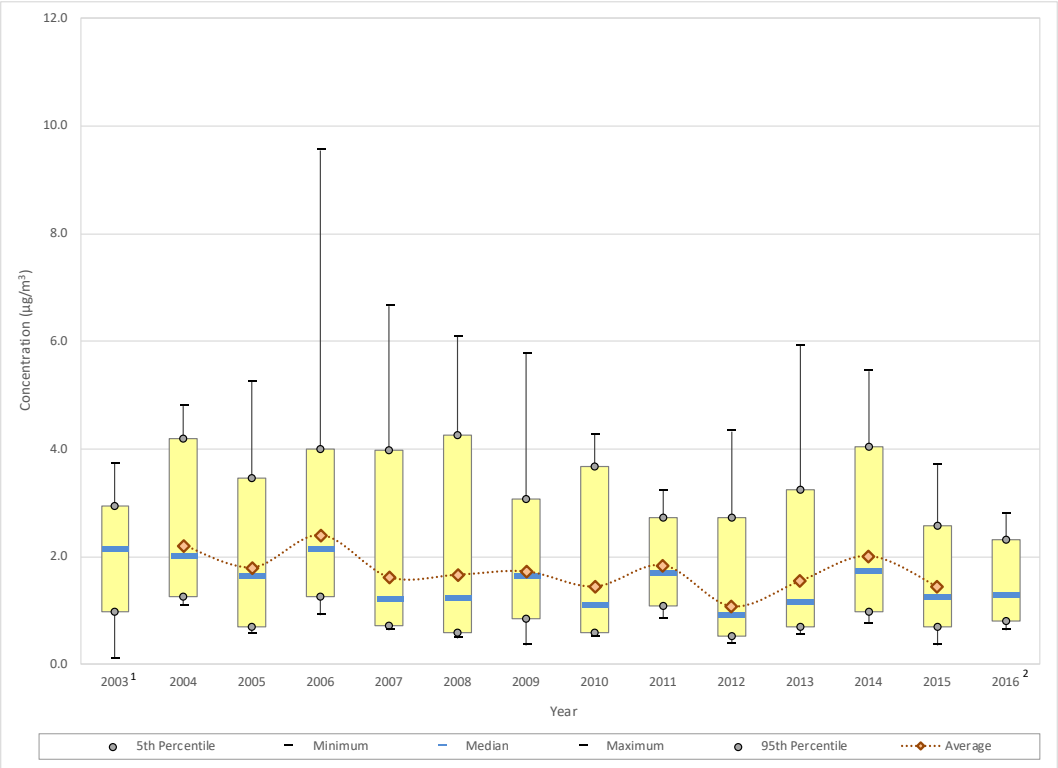
- Although similar maximum concentrations were measured in 2007 and 2008, the change in the 95th percentile between these two years stands out. The second highest concentration measured in 2008 (4.17 µg/m^3) is considerably less than the maximum concentration measured (17.1 µg/m^3).

- The 1-year average concentrations of formaldehyde vary little during the five years between 2008 and 2012, ranging from 2.23 µg/m^3 (2012) to 2.75 µg/m^3 (2010).

- The range of formaldehyde concentrations measured is at a minimum for 2013, and the 1-year average concentration for 2013 is the lowest since 2006; 2006 and 2013 are the only two years with 1-year average concentrations less than 2 µg/m^3.

- The 1-year average concentrations for 2014, 2015, and 2016 fall into a similar range as those calculated for the years prior to 2013.

Figure 9-21. Yearly Statistical Metrics for Acetaldehyde Concentrations Measured at ORFL



[1] A 1-year average is not presented because sampling under the NMP did not begin until April 2003.
[2] A 1-year average is not presented because sampling under the NMP stopped in September 2016.

Observations from Figure 9-21 for acetaldehyde concentrations measured at ORFL include the following:

- Sampling for carbonyl compounds under the NMP began at ORFL in April 2003. A 1-year average concentration is not presented for 2003 because a full year's worth of data is not available, although the range of measurements is provided. This is also true for 2016, when sampling was discontinued at the end of September (the 10-month criteria discussed in Section 3.4.2.2 was not met).

- The maximum acetaldehyde concentration was measured in 2006 (9.55 µg/m^3); two additional acetaldehyde concentrations greater than 6 µg/m^3 were measured in 2007 and 2008. Acetaldehyde concentrations of at least 5 µg/m^3 were measured in half the years of sampling, including each year between 2004 and 2009.

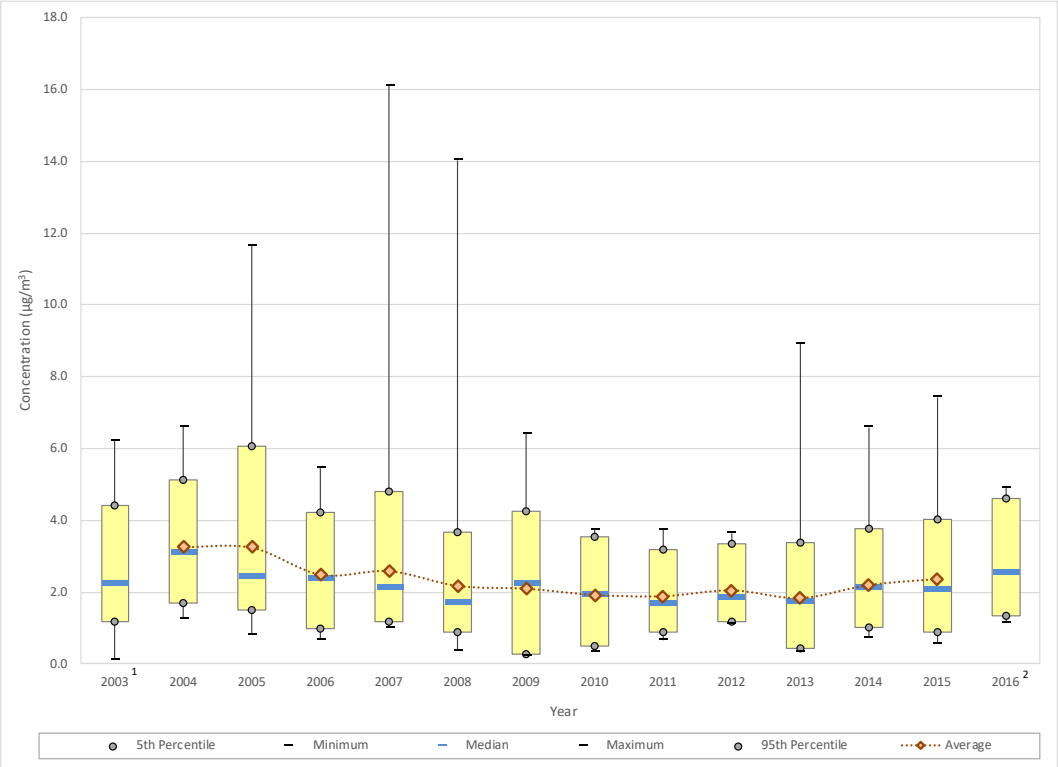
- Between 2004 and 2007, the 1-year average concentrations have an undulating pattern, with a higher year followed by a lower year. Between 2007 and 2009, little change is shown in the 1-year average concentrations, when these averages varied by about 0.1 µg/m^3, despite the considerable increase in the median shown for 2009. The undulating pattern returns between 2009 and 2012.

- The 1-year average concentration is at a minimum for 2012 (1.08 µg/m^3) and represents a significant decrease from 2011 and most of the previous years of sampling. The median concentration decreased by almost half from 2011 to 2012. Only one concentration less than 1 µg/m^3 was measured in 2011 compared to 38 for 2012.

- All of the statistical metrics exhibit increases for 2013, with most exhibiting additional increases for 2014. The 1-year average concentration shown for 2014 is the highest average since 2006, when the maximum concentration was measured.

- All of the statistical metrics exhibit decreases for 2015. The range of concentrations measured decreases further for 2016, with the smallest range of measurements since the onset of sampling. Sampling was discontinued at the end of September 2016, and thus, the concentration profile shown represents only 9 months of sampling.

Figure 9-22. Yearly Statistical Metrics for Formaldehyde Concentrations Measured at ORFL



[1] A 1-year average is not presented because sampling under the NMP did not begin until April 2003.
[2] A 1-year average is not presented because sampling under the NMP stopped in September 2016.

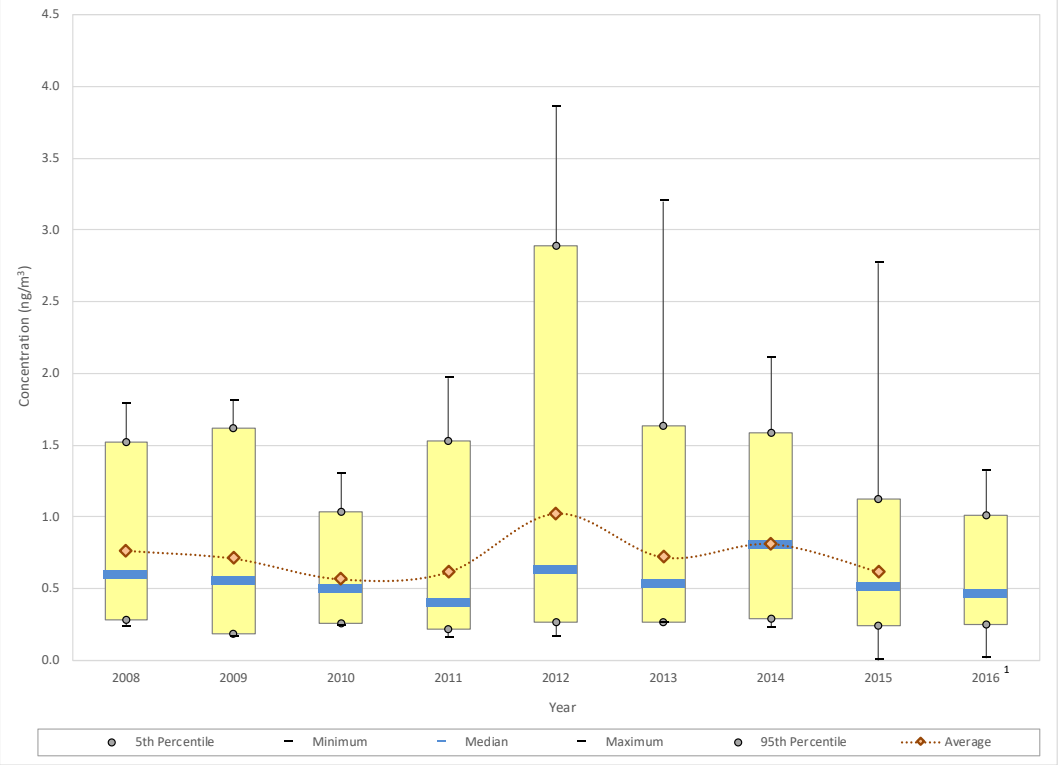
Observations from Figure 9-22 for formaldehyde concentrations measured at ORFL include the following:

- The maximum formaldehyde concentration was measured in 2007 (16.1 µg/m^3), on the same day as the second highest acetaldehyde concentration (September 21, 2007). Formaldehyde concentrations greater than 10 µg/m^3 were also measured in 2005 (two) and 2008 (one).

- The 1-year average concentrations exhibit an overall decreasing trend through 2011, starting at 3.26 µg/m^3 for 2004 and decreasing to 1.89 µg/m^3 by 2011. The statistical metrics for 2007 are the exception to this pattern. However, if the maximum concentration measured in 2007 was excluded from the calculation, the 1-year average concentration would exhibit a consistent decreasing trend across the years through 2011. The 1-year average concentrations hover around 2 µg/m^3 for several years of sampling at ORFL.

- The 1-year average concentration exhibits slight increases for 2014 and 2015. Although a 1-year average is not presented for 2016, the median concentration calculated for 2016 is at its highest in 12 years.

Figure 9-23. Yearly Statistical Metrics for Arsenic (PM_{10}) Concentrations Measured at PAFL



[1] A 1-year average is not presented because sampling under the NMP stopped in September 2016.

Observations from Figure 9-23 for arsenic concentrations measured at PAFL include the following:

- Sampling for PM_{10} metals under the NMP began at PAFL in January 2008; metals sampling occurred on a 1-in-12 day sampling schedule at this site.

- Two of three highest arsenic concentrations, those greater than 3 ng/m^3, were measured at PAFL in 2012, and the other was measured in 2013. Seven arsenic concentrations greater than 2 ng/m^3 have been measured at PAFL, four in 2012 and one each in 2013, 2014, and 2015.

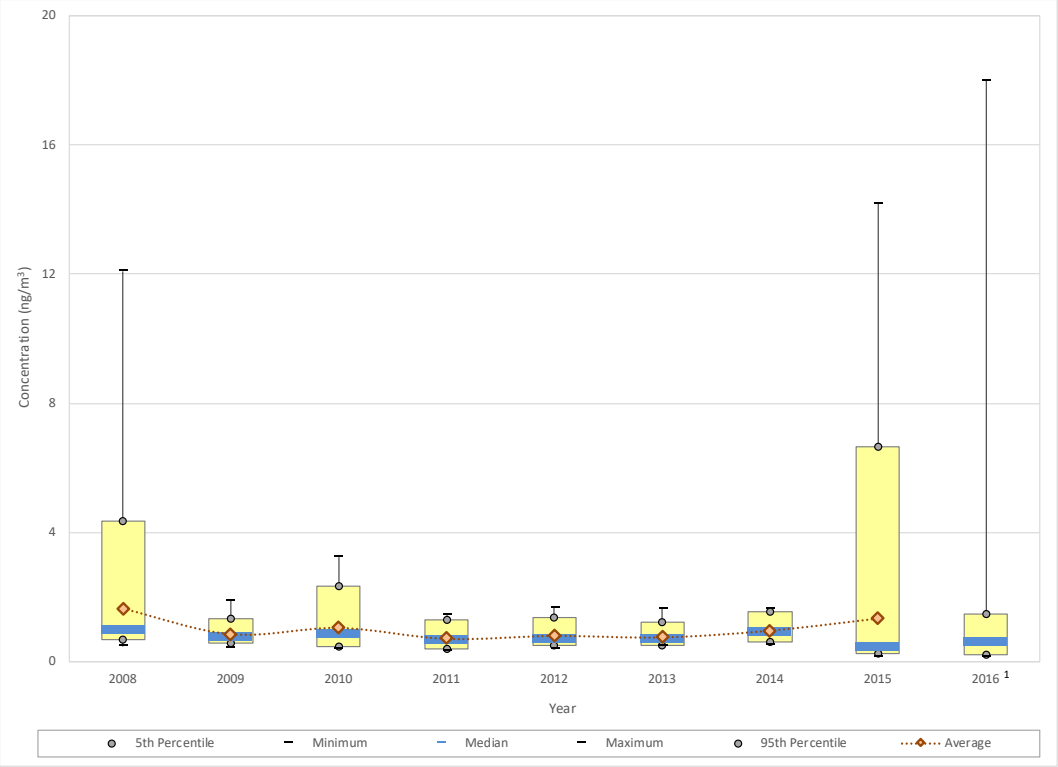
- The 1-year average concentration decreases through 2010, increases slightly for 2011, and increases even more for 2012, when the largest range of arsenic concentrations was measured. The 1-year average concentration for 2012 is the only one greater than 1 ng/m^3.

- The range of concentrations measured decreases for 2013 and again for 2014. Despite this decrease, both the 1-year average and median concentrations exhibit increase for 2014. Fewer concentrations less than 0.5 ng/m^3 were measured in 2014, which accounted for about half of the measurements in 2013 and about a quarter of the measurements for 2014. The difference between the 1-year average and median concentrations is at minimum for 2014, indicating reduced variability in the central tendency for 2014.

- With the exception of the maximum concentration, most of the statistical parameters decreased from 2014 to 2015. The only non-detect of arsenic measured at PAFL was measured in 2015.

- The smallest range of arsenic concentrations since 2010 was measured in 2016. The median concentration exhibits a decrease for 2016 and is less than 0.5 ng/m^3 for only the second time since 2011.

Figure 9-24. Yearly Statistical Metrics for Nickel (PM_{10}) Concentrations Measured at PAFL



[1] A 1-year average is not presented because sampling under the NMP stopped in September 2016.

Observations from Figure 9-24 for nickel concentrations measured at PAFL include the following:

- The maximum nickel concentration was measured at PAFL in 2016 (18.0 ng/m^3), with three additional concentrations greater than 10 ng/m^3 also measured in 2008 (1) and 2015 (two). Nickel concentrations greater than 3.5 ng/m^3 were not measured at this site during any other years of sampling. Less than 1.5 ng/m^3 separates the minimum and maximum concentrations measured in 2009 and between 2011 and 2014.

- The 1-year average concentration decreased by almost half from 2008 to 2009, as concentrations greater than 2 ng/m^3 were not measured in 2009. The 1-year average concentration increased slightly for 2010 as a few concentrations greater than 2 ng/m^3 were again measured. The 1-year average concentration decreased again for 2011, as an even smaller concentration range was measured. The concentration profiles for 2011, 2012, and 2013 are similar to each other. A slight increase in the 1-year average concentration is shown for 2014.

- The range of concentrations increased by an order of magnitude for 2015, at both ends of the concentration range. The two highest nickel concentrations (14.2 ng/m^3 and 11.2 ng/m^3) are an order of magnitude greater than the next two highest concentrations (1.07 ng/m^3 and 1.01 ng/m^3) measured in 2015. Eighteen concentrations measured in 2015 are less than the minimum concentration measured in 2014. This represents 75 percent of the nickel measurements, explaining the 50 percent decrease shown in the median concentration, despite the larger concentration range for 2015. The difference between the 1-year average and median concentrations for 2015 is at a maximum, indicating a high level of variability in the measurements for this year.

- The range of concentrations expands further for 2016, although this is primarily a result of the maximum concentration measured. Two orders of magnitude separate the minimum (0.17 ng/m^3) and maximum (18.0 ng/m^3) concentration measured in 2016; this maximum concentration is the only one greater than 2 ng/m^3 measured in 2016.

9.4 Additional Risk-Based Screening Evaluations

The following risk-based screening evaluations were conducted to characterize risk related to the air toxics measured at each Florida monitoring site. Refer to Sections 3.2, 3.4.2.3, and 3.4.2.4 for definitions and explanations regarding the various toxicity factors, time frames, and calculations associated with these risk-based screenings.

9.4.1 Cancer Risk and Noncancer Hazard Approximations

For the pollutants of interest for the Florida sites, risk was examined by calculating cancer risk and noncancer hazard approximations for each year annual average concentrations could be calculated. These approximations can be used as risk estimates for cancer and noncancer effects attributable to the pollutants of interest. Although the use of these

approximations is limited, they may help identify where policy-makers want to shift their air monitoring priorities. Refer to Section 3.4.2.3 for an explanation of how cancer risk and noncancer hazard approximations are calculated and what limitations are associated with them. Annual averages, cancer UREs and/or noncancer RfCs, and cancer risk and noncancer hazard approximations are presented in Table 9-4, where applicable. Cancer risk approximations are presented as probabilities while the noncancer hazard approximations are ratios and thus, unitless values.

Observations for the Florida sites from Table 9-4 include the following:

- For the four sites at which carbonyl compounds were sampled for, the annual average concentration for each year for formaldehyde is greater than the annual average for acetaldehyde.

- Formaldehyde has the highest cancer risk approximations among the various pollutants of interest for the Florida sites. These cancer risk approximations range from 23.28 in-a-million (AZFL, 2015) to 95.04 in-a-million (AZFL, 2016).

- The cancer risk approximations for acetaldehyde are an order of magnitude less than the cancer risk approximations for formaldehyde, ranging from 1.76 in-a-million (AZFL, 2015) to 3.18 in-a-million (ORFL, 2015).

- For SKFL, the naphthalene cancer risk approximations for 2015 and 2016 are 1.23 in-a-million and 1.68 in-a-million, respectively.

- For PAFL, cancer risk approximations for arsenic (2.66 in-a-million for 2015 and 2.24 in-a-million for 2016) are greater than the cancer risk approximations for nickel (0.64 in-a-million for 2015 and 0.65 in-a-million for 2016).

- All of the noncancer hazard approximations for the site-specific pollutants of interest are less than 1.0, indicating that no adverse noncancer health effects are expected from these individual pollutants. The highest noncancer hazard approximation was calculated for formaldehyde (0.75), based on the 2016 annual average concentration for AZFL. This is the second highest noncancer hazard approximation calculated across the program.

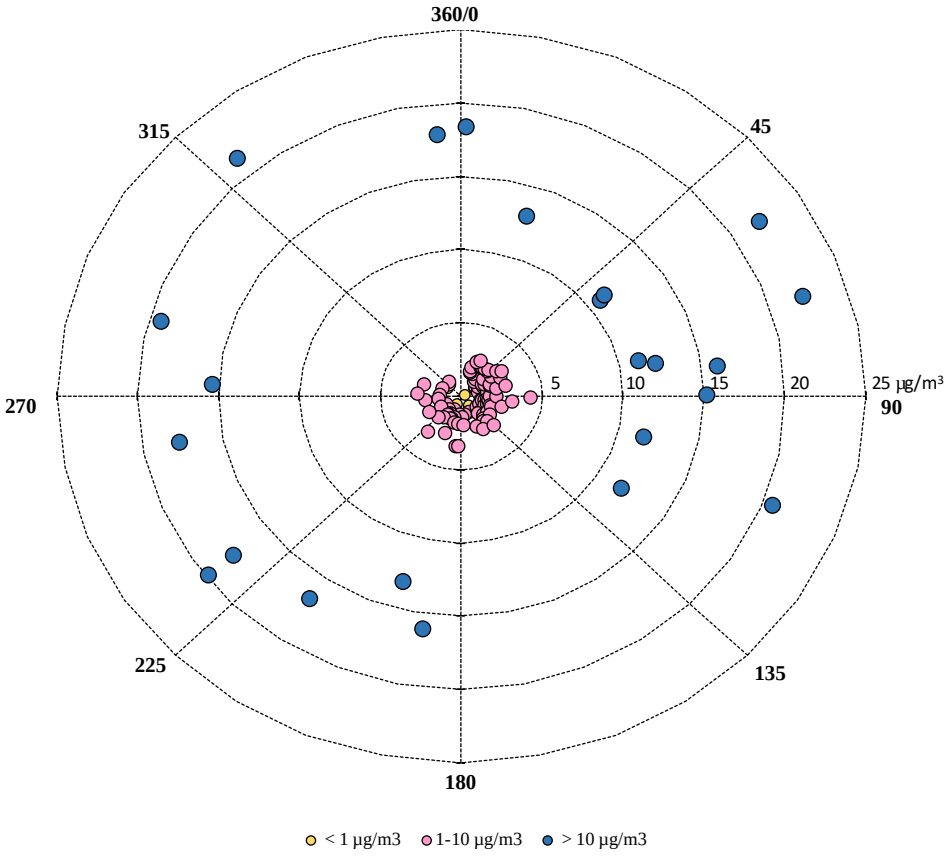
Table 9-4. Risk Approximations for the Florida Monitoring Sites

Pollutant	Cancer URE ($\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	2015				2016			
			# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Risk Approximations		# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Risk Approximations	
					Cancer (in-a-million)	Noncancer (HQ)			Cancer (in-a-million)	Noncancer (HQ)
St. Petersburg, Florida - AZFL										
Acetaldehyde	0.0000022	0.009	58/58	0.80 ± 0.09	1.76	0.09	61/61	1.41 ± 0.21	3.11	0.16
Formaldehyde	0.000013	0.0098	58/58	1.79 ± 0.18	23.28	0.18	61/61	7.31 ± 1.85	95.04	0.75
Pinellas Park, Florida - SKFL										
Acetaldehyde	0.0000022	0.009	58/58	1.19 ± 0.09	2.61	0.13	59/59	1.21 ± 0.11	2.66	0.13
Formaldehyde	0.000013	0.0098	58/58	3.39 ± 0.56	44.04	0.35	59/59	4.72 ± 1.29	61.38	0.48
Naphthalene[a]	0.000034	0.003	59/59	36.05 ± 3.91	1.23	0.01	59/59	49.34 ± 7.81	1.68	0.02
Valrico, Florida - SYFL										
Acetaldehyde	0.0000022	0.009	57/57	1.19 ± 0.13	2.63	0.13	56/56	1.04 ± 0.09	2.28	0.12
Formaldehyde	0.000013	0.0098	57/57	2.37 ± 0.37	30.81	0.24	56/56	2.28 ± 0.25	29.70	0.23
Winter Park, Florida - ORFL										
Acetaldehyde	0.0000022	0.009	58/58	1.45 ± 0.17	3.18	0.16	41/41	1.36 ± 0.14	3.00	0.15
Formaldehyde	0.000013	0.0098	58/58	2.37 ± 0.32	30.81	0.24	41/41	2.71 ± 0.31	35.19	0.28
Orlando, Florida - PAFL										
Arsenic (PM_{10})[a]	0.0043	0.000015	29/30	0.62 ± 0.18	2.66	0.04	24/24	0.52 ± 0.12	2.24	0.03
Nickel (PM_{10})[a]	0.00048	0.00009	30/30	1.34 ± 1.14	0.64	0.01	24/24	1.36 ± 1.47	0.65	0.02

[a] Average concentrations provided below the blue line for this site and/or pollutant are presented in ng/m^3 for ease of viewing.

As an extension of this analysis, pollution roses were created for each of the site-specific pollutants of interest that have a cancer risk approximation greater than 75 in-a-million and/or a noncancer hazard approximation greater than 1.0, where applicable. Thus, a pollution rose was created for AZFL's formaldehyde measurements. A pollution rose is a plot of the ambient concentration versus the wind direction; the magnitude of the concentration is indicated using different colored dots and are shown in relation to the average wind direction oriented about a 16-point compass. Thus, high concentrations may be shown in relation to the direction of potential emissions sources. Hourly wind observations collected at the NWS station at St. Petersburg/Whitted Airport and obtained from NOAA are used in this analysis and were averaged (using vector averaging techniques) to compute daily wind direction averages for comparison to the 24-hour concentration data. This analysis is intended to help identify the geographical area where the emissions sources of these pollutants may have originated. Additional information regarding this analysis is also presented in Section 3.4.2.3. Figure 9-25 presents the pollution rose for all 119 formaldehyde concentrations measured at AZFL over the two-year sampling period.

Figure 9-25. Pollution Rose for Formaldehyde Concentrations Measured at AZFL



Observations from Figure 9-25 include the following:

- Most of the formaldehyde concentrations measured at AZFL are less than 5 µg/m^3, and are shown in pink. These concentrations account for 81 percent of the measurements shown. The higher measurements collected between May and October 2016 are greater than 10 µg/m^3 and are those shown in blue. Concentrations between 5 µg/m^3 and 10 µg/m^3 were not measured at AZFL.

- Formaldehyde concentrations are shown in relation to a variety of average wind directions, including the higher measurements, indicating that the samples were collected on sample days with varying average wind directions. The higher concentrations are shown in relation to all wind directions, except the south-southeast (between 135º and 180º).

- The facility map in Figure 9-3 shows that the only point sources within 2.5 miles of AZFL is located about three-quarters of a mile north of the site.

- The distribution of formaldehyde concentrations on the pollution rose, including the higher concentrations, indicates that the concentrations measured at AZFL do not reflect emissions from any one particular source.

9.4.2 Risk-Based Emissions Assessment

In addition to the risk-based screening discussed above, Tables 9-5 and 9-6 present an evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 9-5 presents the 10 pollutants with the highest emissions from the 2014 NEI (version 1) that have cancer toxicity factors. Table 9-5 also presents the 10 pollutants with the highest toxicity-weighted emissions, based on the weighting schema described in Section 3.4.2.4. Lastly, Table 9-5 provides the pollutants with the highest cancer risk approximations (in-a-million) for each site, as presented in Table 9-4. Cancer risk approximations for 2015 are presented in green while approximations for 2016 are in white. The emissions, toxicity-weighted emissions, and cancer risk approximations are shown in descending order in Table 9-5. Table 9-6 presents similar information, but is limited to those pollutants with noncancer toxicity factors.

Because not all pollutants have both cancer and noncancer toxicity factors, the highest emitted pollutants in the cancer table may be different from the noncancer table, although the actual quantity of emissions is the same. The cancer risk and noncancer hazard approximations based on each site's annual averages are limited to the pollutants of interest identified for each site. In addition, the cancer risk and noncancer hazard approximations are limited to those pollutants with enough data to meet the criteria for annual averages to be calculated. A more in-depth discussion of this analysis is provided in Section 3.4.2.4. Similar to the cancer risk and

noncancer hazard approximations provided in Section 9.4.1, this analysis may help policy-makers prioritize their air monitoring activities.

Observations from Table 9-5 include the following:

- Benzene, formaldehyde, and ethylbenzene are the highest emitted pollutants with cancer UREs in Pinellas, Hillsborough, and Orange Counties.

- Formaldehyde, ethylene oxide, benzene have the highest toxicity-weighted emissions for Pinellas County. Formaldehyde, benzene, and 1,3-butadiene have the highest toxicity-weighted emissions for Hillsborough County. Hexavalent chromium, formaldehyde, and benzene have the highest toxicity-weighted emissions for Orange County.

- Seven of the highest emitted pollutants in Pinellas County also have the highest toxicity-weighted emissions; this is also true for Orange County. Eight of the highest emitted pollutants in Hillsborough County also have the highest toxicity-weighted emissions.

- Formaldehyde, which has the highest cancer risk approximations for each of the sites sampling carbonyl compounds, is one of the highest emitted pollutants in each county and has one of the highest toxicity-weighted emissions for each county. This is also true for acetaldehyde for Hillsborough County, but acetaldehyde does not appear among those pollutants with the highest toxicity-weighted emissions for Pinellas or Orange Counties (it ranks 11th for both counties).

- Naphthalene, which is a pollutant of interest for SFKL, is one of the highest emitted pollutants in all three counties and has one of the highest toxicity-weighted emissions for each county.

- POM, Groups 2b and 2d are also among the highest emitted "pollutants" in all three counties and appear among the pollutants with the highest toxicity-weighted emissions. POM, Group 2b includes several PAHs sampled for at SKFL, including fluorene and acenaphthene, both of which failed screens for SKFL but were not identified as pollutants of interest.

- Arsenic and nickel are the pollutants of interest for PAFL. Neither metal appears among the highest emitted in Orange County. Arsenic does not appear among the pollutants with the highest toxicity-weighted emissions for Orange County, while nickel ranks ninth.

Table 9-5. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Florida Monitoring Sites

Top 10 Total Emissions for Pollutants with Cancer UREs (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
St. Petersburg, Florida (Pinellas County) – AZFL					
Benzene	251.18	Formaldehyde	2.45E-03	Formaldehyde	95.04
Formaldehyde	188.23	Ethylene oxide	2.00E-03	Formaldehyde	23.28
Ethylbenzene	165.34	Benzene	1.96E-03	Acetaldehyde	3.11
Acetaldehyde	107.84	1,3-Butadiene	1.20E-03	Acetaldehyde	1.76
1,3-Butadiene	39.94	Hexavalent Chromium, PM	8.14E-04		
Naphthalene	21.80	Naphthalene	7.41E-04		
Trichloroethylene	4.79	Ethylbenzene	4.13E-04		
POM, Group 2b	4.37	POM, Group 2b	3.85E-04		
Dichloromethane	3.77	Nickel, PM	3.66E-04		
POM, Group 2d	3.42	POM, Group 2d	3.01E-04		
Pinellas Park, Florida (Pinellas County) – SKFL					
Benzene	251.18	Formaldehyde	2.45E-03	Formaldehyde	61.38
Formaldehyde	188.23	Ethylene oxide	2.00E-03	Formaldehyde	44.04
Ethylbenzene	165.34	Benzene	1.96E-03	Acetaldehyde	2.66
Acetaldehyde	107.84	1,3-Butadiene	1.20E-03	Acetaldehyde	2.61
1,3-Butadiene	39.94	Hexavalent Chromium, PM	8.14E-04	Naphthalene	1.68
Naphthalene	21.80	Naphthalene	7.41E-04	Naphthalene	1.23
Trichloroethylene	4.79	Ethylbenzene	4.13E-04		
POM, Group 2b	4.37	POM, Group 2b	3.85E-04		
Dichloromethane	3.77	Nickel, PM	3.66E-04		
POM, Group 2d	3.42	POM, Group 2d	3.01E-04		

[1]Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Table 9-5. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Florida Monitoring Sites (Continued)

Top 10 Total Emissions for Pollutants with Cancer UREs (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Valrico, Florida (Hillsborough County) – SYFL					
Benzene	355.47	Formaldehyde	4.31E-03	Formaldehyde	30.81
Formaldehyde	331.57	Benzene	2.77E-03	Formaldehyde	29.70
Ethylbenzene	233.29	1,3-Butadiene	1.75E-03	Acetaldehyde	2.63
Acetaldehyde	176.93	Arsenic, PM	1.22E-03	Acetaldehyde	2.28
1,3-Butadiene	58.39	Naphthalene	1.13E-03		
Naphthalene	33.25	POM, Group 2b	6.58E-04		
POM, Group 2b	7.47	Ethylbenzene	5.83E-04		
Methyl *tert* butyl ether	6.86	Hexavalent Chromium, PM	5.15E-04		
POM, Group 2d	5.07	POM, Group 2d	4.46E-04		
Trichloroethylene	3.84	Acetaldehyde	3.89E-04		
Winter Park, Florida (Orange County) – ORFL					
Benzene	343.02	Hexavalent Chromium, PM	1.24E-02	Formaldehyde	35.19
Formaldehyde	333.48	Formaldehyde	4.34E-03	Formaldehyde	30.81
Ethylbenzene	232.56	Benzene	2.68E-03	Acetaldehyde	3.18
Acetaldehyde	160.40	1,3-Butadiene	1.63E-03	Acetaldehyde	3.00
1,3-Butadiene	54.32	Naphthalene	1.11E-03		
Naphthalene	32.58	Ethylbenzene	5.81E-04		
POM, Group 2b	6.32	POM, Group 2b	5.56E-04		
Tetrachloroethylene	5.45	POM, Group 2d	4.27E-04		
Trichloroethylene	4.94	Nickel, PM	4.10E-04		
POM, Group 2d	4.86	POM, Group 5a	3.81E-04		

[1]Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Table 9-5. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Florida Monitoring Sites (Continued)

Top 10 Total Emissions for Pollutants with Cancer UREs (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Orlando, Florida (Orange County) – PAFL					
Benzene	343.02	Hexavalent Chromium, PM	1.24E-02	Arsenic	2.66
Formaldehyde	333.48	Formaldehyde	4.34E-03	Arsenic	2.24
Ethylbenzene	232.56	Benzene	2.68E-03	Nickel	0.65
Acetaldehyde	160.40	1,3-Butadiene	1.63E-03	Nickel	0.64
1,3-Butadiene	54.32	Naphthalene	1.11E-03		
Naphthalene	32.58	Ethylbenzene	5.81E-04		
POM, Group 2b	6.32	POM, Group 2b	5.56E-04		
Tetrachloroethylene	5.45	POM, Group 2d	4.27E-04		
Trichloroethylene	4.94	Nickel, PM	4.10E-04		
POM, Group 2d	4.86	POM, Group 5a	3.81E-04		

[1]Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Table 9-6. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the Florida Monitoring Sites

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Hazard Approximation (HQ)**
St. Petersburg, Florida (Pinellas County) – AZFL					
Toluene	1,120.26	Acrolein	683,946.60	Formaldehyde	0.75
Xylenes	665.70	1,3-Butadiene	19,971.07	Formaldehyde	0.18
Methanol	658.85	Formaldehyde	19,207.50	Acetaldehyde	0.16
Benzene	251.18	Acetaldehyde	11,982.55	Acetaldehyde	0.09
Ethylene glycol	242.14	Nickel, PM	8,472.67		
Hexane	228.78	Benzene	8,372.75		
Formaldehyde	188.23	Naphthalene	7,267.81		
Ethylbenzene	165.34	Xylenes	6,656.96		
Acetaldehyde	107.84	Lead, PM	4,922.16		
Styrene	80.67	Antimony, PM	3,500.85		
Pinellas Park, Florida (Pinellas County) – SKFL					
Toluene	1,120.26	Acrolein	683,946.60	Formaldehyde	0.48
Xylenes	665.70	1,3-Butadiene	19,971.07	Formaldehyde	0.35
Methanol	658.85	Formaldehyde	19,207.50	Acetaldehyde	0.13
Benzene	251.18	Acetaldehyde	11,982.55	Acetaldehyde	0.13
Ethylene glycol	242.14	Nickel, PM	8,472.67	Naphthalene	0.02
Hexane	228.78	Benzene	8,372.75	Naphthalene	0.01
Formaldehyde	188.23	Naphthalene	7,267.81		
Ethylbenzene	165.34	Xylenes	6,656.96		
Acetaldehyde	107.84	Lead, PM	4,922.16		
Styrene	80.67	Antimony, PM	3,500.85		

[1]Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Table 9-6. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the Florida Monitoring Sites (Continued)

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific) [1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Hazard Approximation (HQ)**
Valrico, Florida (Hillsborough County) – SYFL					
Hydrochloric acid	2,725.32	Acrolein	1,502,391.89	Formaldehyde	0.24
Toluene	1,474.94	Hydrochloric acid	136,266.15	Formaldehyde	0.23
Xylenes	923.76	Formaldehyde	33,833.20	Acetaldehyde	0.13
Methanol	885.69	Hydrofluoric acid	29,839.55	Acetaldehyde	0.12
Hydrofluoric acid	417.75	1,3-Butadiene	29,196.33		
Benzene	355.47	Bromomethane	24,759.22		
Ethylene glycol	339.03	Acetaldehyde	19,658.53		
Formaldehyde	331.57	Arsenic, PM	18,968.49		
Hexane	330.23	Lead, PM	13,955.68		
Ethylbenzene	233.29	Benzene	11,849.02		
Winter Park, Florida (Orange County) – ORFL					
Toluene	1,537.19	Acrolein	1,246,277.62	Formaldehyde	0.28
Xylenes	921.43	Formaldehyde	34,028.31	Formaldehyde	0.24
Methanol	822.73	1,3-Butadiene	27,160.32	Acetaldehyde	0.16
Benzene	343.02	Chlorine	26,988.93	Acetaldehyde	0.15
Formaldehyde	333.48	Hexamethylene-1,6-diisocyanate, gas	18,000.00		
Ethylene glycol	322.93	Acetaldehyde	17,821.97		
Hexane	314.56	Benzene	11,434.08		
Ethylbenzene	232.56	Naphthalene	10,861.47		
Acetaldehyde	160.40	Hexavalent Chromium, PM	10,313.82		
Styrene	150.70	Nickel, PM	9,484.79		

[1]Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Table 9-6. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the Florida Monitoring Sites (Continued)

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific) [1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Hazard Approximation (HQ)**
Orlando, Florida (Orange County) – PAFL					
Toluene	1,537.19	Acrolein	1,246,277.62	Arsenic	0.04
Xylenes	921.43	Formaldehyde	34,028.31	Arsenic	0.03
Methanol	822.73	1,3-Butadiene	27,160.32	Nickel	0.02
Benzene	343.02	Chlorine	26,988.93	Nickel	0.01
Formaldehyde	333.48	Hexamethylene-1,6-diisocyanate, gas	18,000.00		
Ethylene glycol	322.93	Acetaldehyde	17,821.97		
Hexane	314.56	Benzene	11,434.08		
Ethylbenzene	232.56	Naphthalene	10,861.47		
Acetaldehyde	160.40	Hexavalent Chromium, PM	10,313.82		
Styrene	150.70	Nickel, PM	9,484.79		

[1]Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Observations from Table 9-6 include the following:

- Toluene, xylenes, methanol, and benzene are the highest emitted pollutants with noncancer RfCs in Pinellas and Orange Counties. Hydrochloric acid is the highest emitted pollutant in Hillsborough County, followed by toluene, xylenes, and methanol.

- Acrolein has the highest toxicity-weighted emissions of the pollutants with noncancer RfCs for each county, but is not among the highest emitted pollutants in the three Florida counties.

- Four of the highest emitted pollutants in Pinellas and Hillsborough Counties also have the highest toxicity-weighted emissions. Three of the highest emitted pollutants in Orange County also have the highest toxicity-weighted emissions.

- Formaldehyde appears on both emissions-based lists for each county. Acetaldehyde appears on both lists for Pinellas and Orange Counties; while acetaldehyde is not among the highest emitted in Hillsborough County, it is among those with the highest toxicity-weighted emissions.

- Naphthalene is among the pollutants with the highest toxicity-weighted emissions for two of the three counties (except Hillsborough County), but is not among the highest emitted pollutants (with a noncancer RfC) in any of these counties.

- Arsenic does not appear among the highest emitted pollutants in Orange County, or among those with the highest toxicity-weighted emissions for this county. Nickel also does not appear among the pollutants with the highest emissions for Orange County, but does rank tenth for its toxicity-weighted emissions.

- Several metals appear among those with the highest toxicity-weighted emissions for Pinellas and Hillsborough Counties, ranking highest for Hillsborough County, but none of these metals are among the highest emitted.

9.5 Summary of the 2015-2016 Monitoring Data for the Florida Monitoring Sites

Results from several of the data analyses described in this section include the following:

- ❖ *Acetaldehyde and formaldehyde failed screens for AZFL, SYFL, and ORFL, where only carbonyl compounds were sampled. Formaldehyde, acetaldehyde, and naphthalene failed screens for SKFL. Arsenic and nickel failed screens for PAFL.*

- ❖ *The 25 highest formaldehyde concentrations measured across the program in 2016 were measured at AZFL and SKFL. The 2016 annual averages for these sites are the second and fifth highest annual average concentrations of formaldehyde, respectively.*

- ❖ *Concentrations of naphthalene have a decreasing trend at SKFL through 2015 but increased somewhat for 2016. Acetaldehyde concentrations have a slight decreasing trend at SYFL.*

- *Formaldehyde has the highest cancer risk approximations among the pollutants of interest for each Florida site, where carbonyl compounds were sampled. None of the pollutants of interest have noncancer hazard approximations greater than an HQ of 1.0.*

10.0 Sites in Illinois

This section summarizes those data from samples collected at the NATTS and UATMP sites in Illinois and generated by ERG, EPA's contract laboratory for the NMP, over the 2015 and 2016 monitoring efforts. This section also examines the spatial and temporal characteristics of the ambient monitoring concentrations and reviews them through the context of risk. Readers are encouraged to refer to Sections 1 through 4 for detailed discussions and definitions regarding the various data analyses presented below.

Data generated by sources other than ERG, EPA's contract laboratory for the NMP, are not included in the data analyses contained in this report.

10.1 Site Characterization

This section characterizes the Illinois monitoring sites by providing a description of the nearby area surrounding each monitoring site; plotting emissions sources surrounding the monitoring sites; and presenting traffic data and other characterizing information for each site. This information is provided to give the reader insight regarding factors that may influence the air quality near the sites and assist in the interpretation of the ambient measurements.

Two monitoring sites are located in northwestern suburbs of Greater Chicago; NBIL is located in Northbrook and SPIL is located in Schiller Park. A third site (ROIL) is located in Roxana, just north of the St. Louis CBSA. Figures 10-1 and 10-2 present composite satellite images retrieved from ArcGIS Explorer showing the Chicago monitoring sites and their immediate surroundings. Figure 10-3 identifies the nearby point source emissions locations by source category, as reported in the 2014 NEI for point sources, version 1, for NBIL and SPIL. Note that only sources within 10 miles of the sites are included in the facility counts provided in Figure 10-3. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have a direct effect on the air quality at the monitoring sites. Further, this boundary provides both the proximity of emissions sources to the monitoring sites as well as the quantity of such sources within a given distance of the sites. Sources outside the 10-mile boundaries are still visible on the map for reference but have been grayed out to emphasize emissions sources within the boundaries. Figures 10-4 and 10-5 present the composite satellite image and facility map for ROIL, respectively. Table 10-1 provides supplemental geographical information such as land use, location setting, and locational coordinates for each site. Each figure and table is discussed in detail in the paragraphs that follow.

Figure 10-1. Northbrook, Illinois (NBIL) Monitoring Site

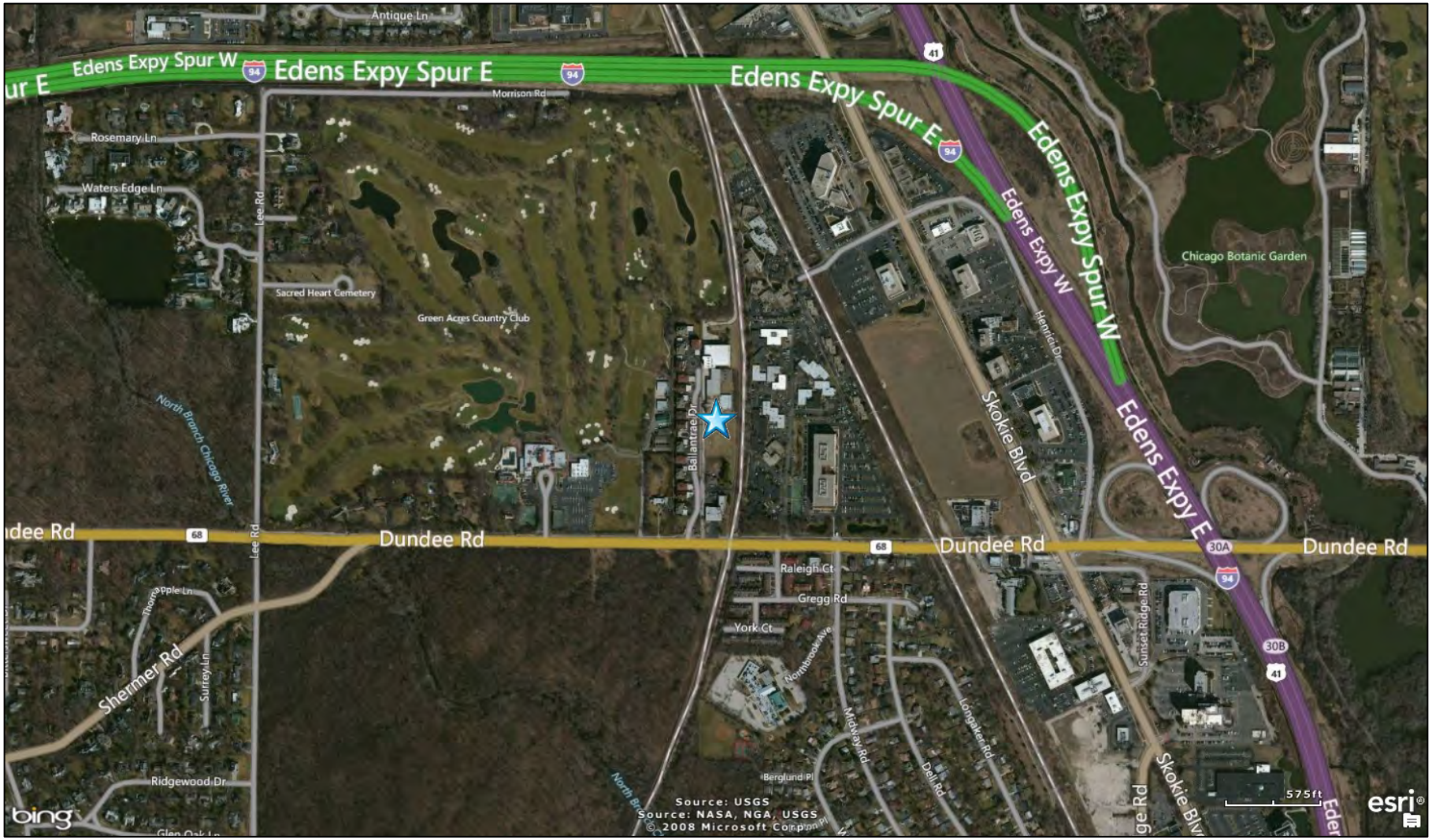


Figure 10-2. Schiller Park, Illinois (SPIL) Monitoring Site

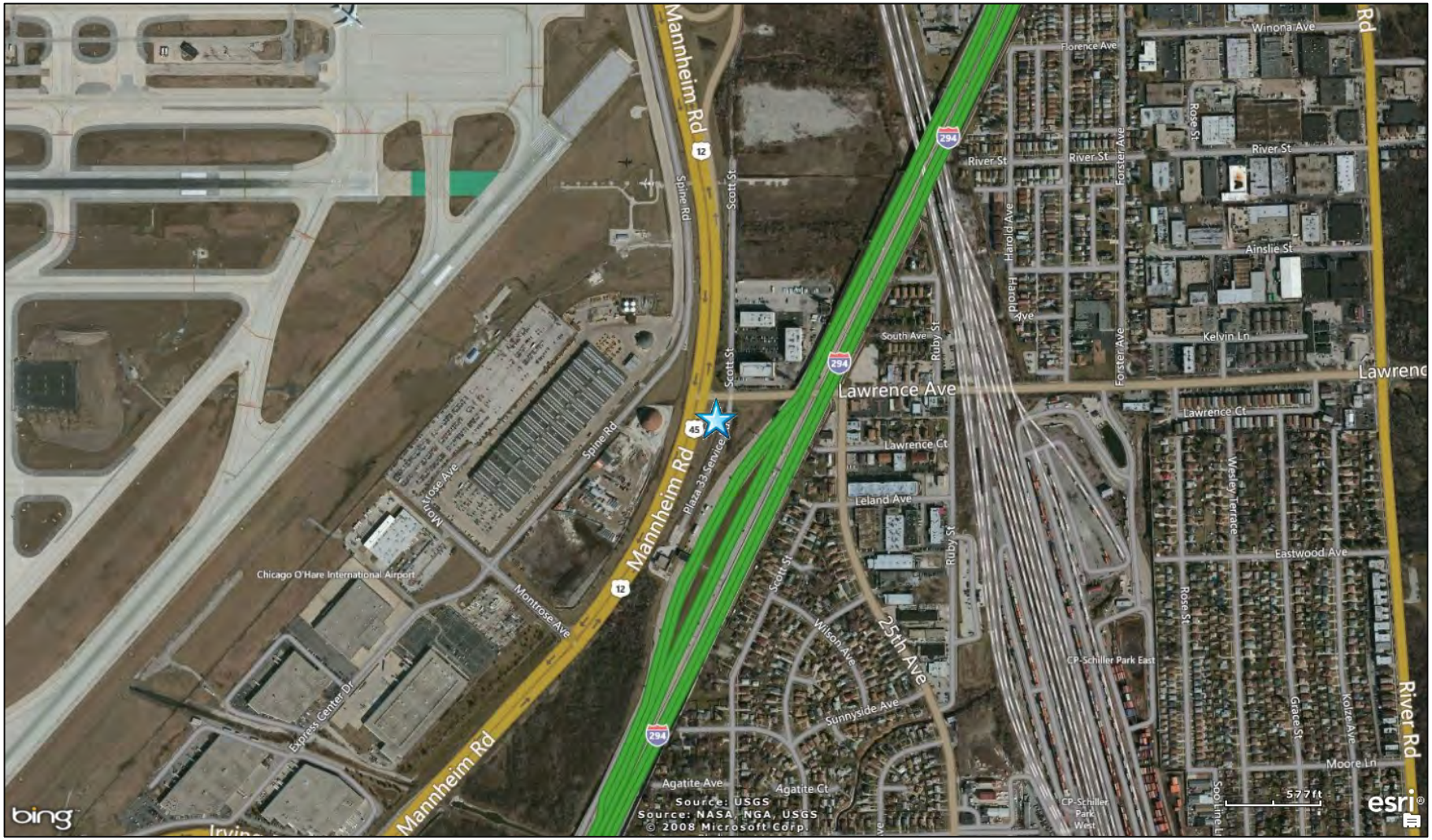


Figure 10-3. NEI Point Sources Located Within 10 Miles of NBIL and SPIL

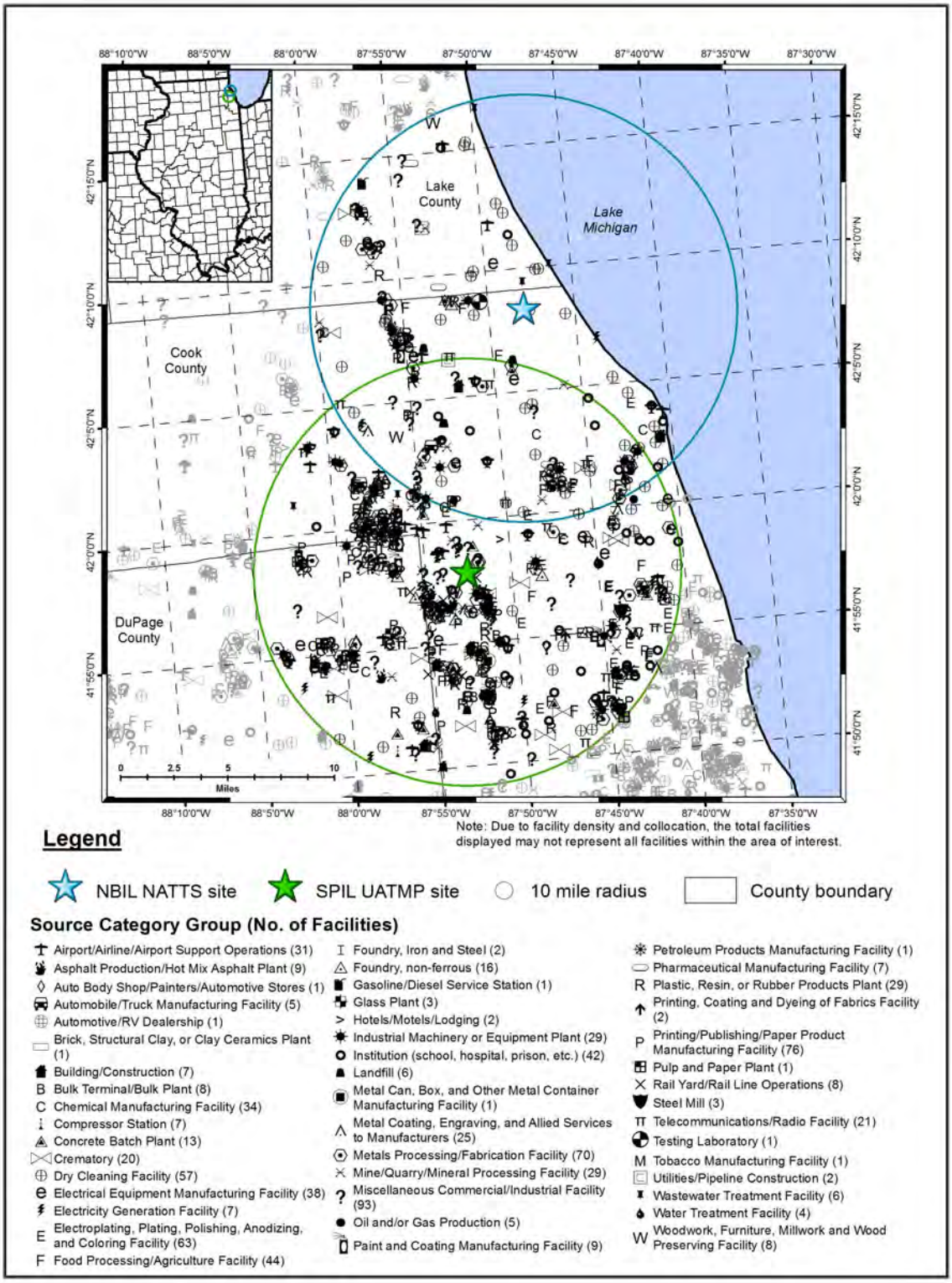


Figure 10-4. Roxana, Illinois (ROIL) Monitoring Site

Figure 10-5. NEI Point Sources Located Within 10 Miles of ROIL

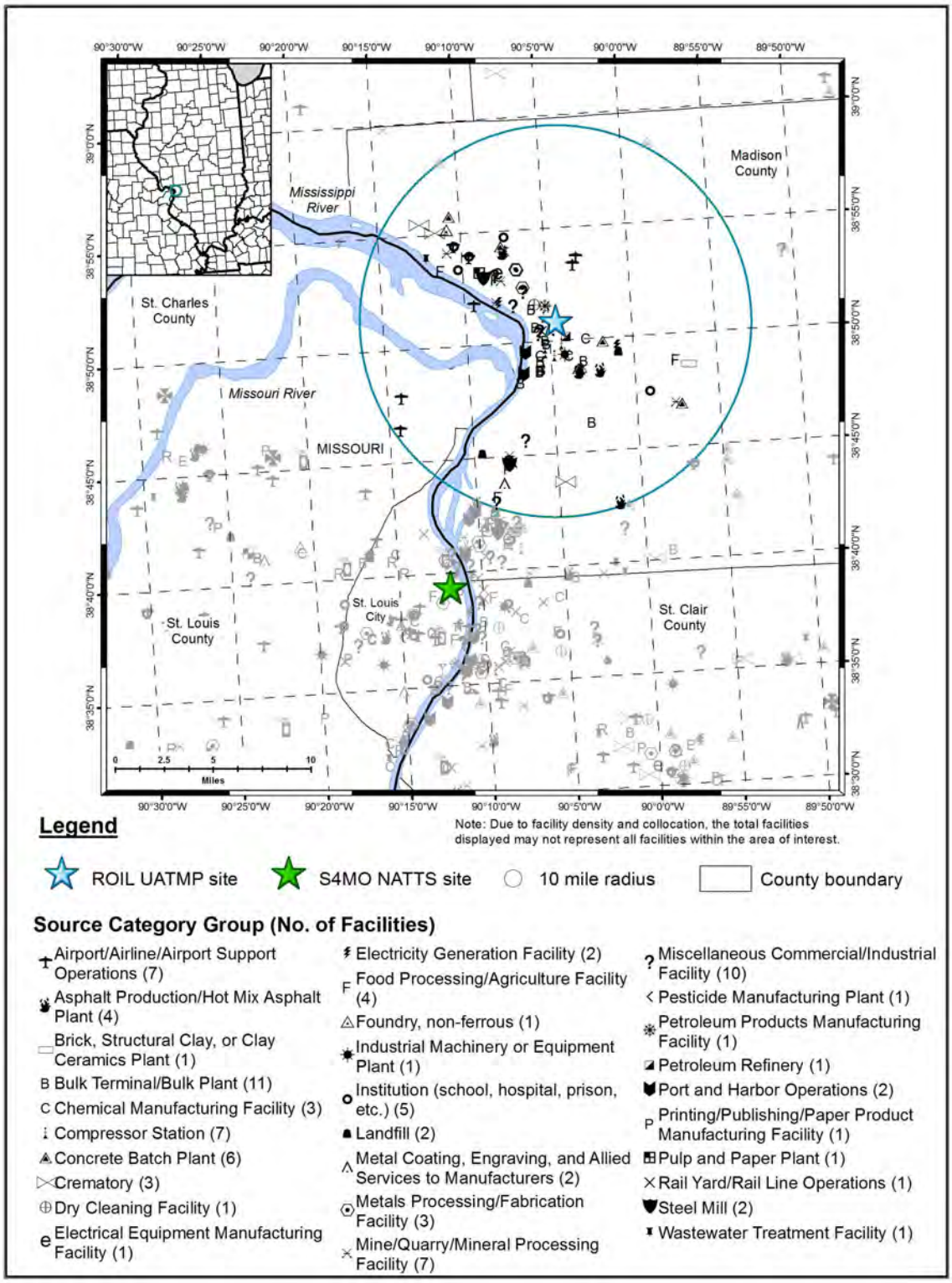


Table 10-1. Geographical Information for the Illinois Monitoring Sites

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Annual Average Daily Traffic[1]	Intersection Used for Traffic Data
NBIL	17-031-4201	Northbrook	Cook	Chicago-Naperville-Elgin IL-IN-WI	42.139996, -87.799227	Residential	Suburban	115,100	I-94 north of intersection with Dundee Rd
SPIL	17-031-3103	Schiller Park	Cook	Chicago-Naperville-Elgin IL-IN-WI	41.965193, -87.876265	Mobile	Suburban	193,800	I-294, just south of Lawrence Ave
ROIL	17-119-9010	Roxana	Madison	St. Louis, MO-IL	38.848382, -90.076413	Industrial	Suburban	6,850	S Central Ave at W Thomas St

[1] AADT reflects 2013 data for SPIL, 2014 data for NBIL, and 2015 data for ROIL (IL DOT, 2017)

BOLD ITALICS = EPA-designated NATTS Site

NBIL is located on the property of the Northbrook Water Filtration Station. Figure 10-1 shows that NBIL is located off State Highway 68 (Dundee Road), near Exit 30 on I-94. A rail line runs north-south next to the water filtration station, separating the municipal buildings and nearby residential subdivision from a business complex to the east, and intersects Dundee Road just south of the monitoring site. The surrounding area is suburban and residential. Commercial, residential, and forested areas surround the site, along with a country club and golf course. The NBIL monitoring site is the Chicago NATTS site.

SPIL is located on the eastern edge of the Chicago-O'Hare International Airport, between Mannheim Road and I-294, just north of the toll plaza. The nearest runway is less than one-half mile from the site. The surrounding area is classified as suburban and mobile. Commercial and residential areas are located to the east of the airport and I-294. The rail yard located to the east of I-294 is an intermodal terminal/facility that has been closed (Podmolik, 2015).

NBIL and SPIL are located within 13 miles of each other. Each site is located within 10 miles of numerous point sources, although the quantity of emissions sources is higher near SPIL than NBIL, as shown in Figure 10-3. The source categories with the largest number of sources within 10 miles of NBIL and SPIL include printing/publishing/paper product manufacturing; metals processing/fabrication; electroplating, plating, polishing, anodizing, and coloring; dry cleaning; food processing/agriculture; and institutions (schools, hospitals, prisons, etc.). Few point sources are located within 2 miles of NBIL, with most of the sources located farther west or south. The closest source to NBIL is plotted under the symbol for the site in Figure 10-3; this source is a dry cleaning facility. Besides the airport and related operations, the closest point source to SPIL is involved in electroplating, plating, polishing, anodizing, and coloring.

The ROIL monitoring site in Roxana is located at the fence line of a petroleum refinery. Although this area is industrial, residential areas are wedged between the industrial properties, as Figure 10-4 shows. Just north of the monitoring site are a junior high school and a high school, whose track and tennis courts are shown across the street from the monitoring site. North of the schools is a community park. Ambient monitoring data from this location will be used to assess near-field concentrations in the neighboring community, with emphasis on comparing and contrasting these data to the St. Louis NATTS site (S4MO), which is also pictured in Figure 10-5 (WUSTL, 2013 and 2016). The Mississippi River, which is the border between Missouri and Illinois, is just over a mile and a half west of the ROIL monitoring site.

In addition to showing the ROIL monitoring site's location relative to the S4MO monitoring site, Figure 10-5 also shows the point sources within 10 miles of each site (although only the facilities within 10 miles of ROIL are included in the facility counts below the map). There are numerous emissions sources surrounding ROIL, most of which are located to the south and northwest of the site. Many of the sources within 2 miles of ROIL are involved in or related to the petroleum industry. A petroleum refinery, multiple compressor stations, and several bulk terminals surround this site. Other nearby sources include a rail yard, an industrial machinery/equipment facility, and several chemical manufacturers.

In addition to providing city, county, CBSA, and land use/location setting information, Table 10-1 also contains traffic volume information for each site as well as the location for which the traffic volume was obtained. This information is provided because emissions from motor vehicles can significantly affect concentrations measured at a given monitoring site. SPIL experiences a higher traffic volume compared to NBIL, although the traffic volumes near these two sites are both significantly greater than the traffic volume near ROIL. SPIL's traffic volume is the third highest among NMP sites. The traffic volume for NBIL ranks tenth among NMP sites while traffic volume near ROIL is in the bottom third. Note that the traffic volumes presented for NBIL and SPIL are from interstate highways while the traffic volume for ROIL is not.

10.2 Pollutants of Interest

The risk-based screening process described in Section 3.2 was performed for each site to identify site-specific "pollutants of interest," which allows analysts and readers to focus on a subset of pollutants through the context of risk. For each site, each pollutant's preprocessed daily measurement was compared to its associated risk screening value. If the concentration was greater than the risk screening value, then the concentration "failed the screen." The site-specific results of this risk-based screening process are presented in Table 10-2 and incorporate measurements from both 2015 and 2016. Pollutants of interest are those for which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens and are shaded in gray in Table 10-2. It is important to note which pollutants were sampled for at each site when reviewing the results of this analysis. VOCs, carbonyl compounds, SNMOCs, metals (PM_{10}), and PAHs were sampled for at NBIL, while VOCs and carbonyl compounds were sampled for at SPIL and ROIL. Note that sampling at ROIL was discontinued at the end of July 2015.

Table 10-2. 2015-2016 Risk-Based Screening Results for the Illinois Monitoring Sites

Pollutant	Screening Value ($\mu g/m^3$)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Northbrook, Illinois - NBIL						
Acetaldehyde	0.45	116	116	100.00	11.34	11.34
Formaldehyde	0.077	116	116	100.00	11.34	22.68
Benzene	0.13	113	113	100.00	11.05	33.72
Carbon Tetrachloride	0.17	113	113	100.00	11.05	44.77
Arsenic (PM_{10})	0.00023	107	113	94.69	10.46	55.23
1,2-Dichloroethane	0.038	103	103	100.00	10.07	65.30
Naphthalene	0.029	85	116	73.28	8.31	73.61
1,3-Butadiene	0.03	67	107	62.62	6.55	80.16
Acenaphthene	0.011	49	110	44.55	4.79	84.95
Fluorene	0.011	47	104	45.19	4.59	89.54
Fluoranthene	0.011	37	116	31.90	3.62	93.16
p-Dichlorobenzene	0.091	21	50	42.00	2.05	95.21
Hexachloro-1,3-butadiene	0.045	11	11	100.00	1.08	96.29
Nickel (PM_{10})	0.0021	11	113	9.73	1.08	97.36
Chloroform	9.8	8	113	7.08	0.78	98.14
Ethylbenzene	0.4	6	112	5.36	0.59	98.73
Benzo(a)pyrene	0.00057	4	113	3.54	0.39	99.12
Manganese (PM_{10})	0.03	3	113	2.65	0.29	99.41
Trichloroethylene	0.2	2	38	5.26	0.20	99.61
Bromomethane	0.5	1	111	0.90	0.10	99.71
1,2-Dibromoethane	0.0017	1	1	100.00	0.10	99.80
Dichloromethane	60	1	113	0.88	0.10	99.90
Lead (PM_{10})	0.015	1	113	0.88	0.10	100.00
Total		1,023	2,228	45.92		

Table 10-2. 2015-2016 Risk-Based Screening Results for the Illinois Monitoring Sites (Continued)

Pollutant	Screening Value (µg/m^3)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Schiller Park, Illinois - SPIL						
Acetaldehyde	0.45	118	118	100.00	15.07	15.07
Benzene	0.13	118	118	100.00	15.07	30.14
Carbon Tetrachloride	0.17	118	118	100.00	15.07	45.21
Formaldehyde	0.077	118	118	100.00	15.07	60.28
1,3-Butadiene	0.03	117	118	99.15	14.94	75.22
1,2-Dichloroethane	0.038	112	114	98.25	14.30	89.53
Trichloroethylene	0.2	36	90	40.00	4.60	94.13
p-Dichlorobenzene	0.091	14	50	28.00	1.79	95.91
Ethylbenzene	0.4	9	118	7.63	1.15	97.06
Hexachloro-1,3-butadiene	0.045	9	10	90.00	1.15	98.21
Propionaldehyde	0.8	9	118	7.63	1.15	99.36
Tetrachloroethylene	3.8	3	118	2.54	0.38	99.74
Bromomethane	0.5	1	116	0.86	0.13	99.87
1,2-Dibromoethane	0.0017	1	1	100.00	0.13	100.00
Total		783	1,325	59.09		
Roxana, Illinois - ROIL						
Acetaldehyde	0.45	33	33	100.00	17.01	17.01
Formaldehyde	0.077	33	33	100.00	17.01	34.02
Benzene	0.13	32	32	100.00	16.49	50.52
Carbon Tetrachloride	0.17	32	32	100.00	16.49	67.01
1,2-Dichloroethane	0.038	31	31	100.00	15.98	82.99
1,3-Butadiene	0.03	25	30	83.33	12.89	95.88
Ethylbenzene	0.4	4	32	12.50	2.06	97.94
Propionaldehyde	0.8	2	31	6.45	1.03	98.97
1,2-Dibromoethane	0.0017	1	1	100.00	0.52	99.48
Hexachloro-1,3-butadiene	0.045	1	2	50.00	0.52	100.00
Total		194	257	75.49		

Observations from Table 10-3 include the following:

- The number of pollutants failing screens for NBIL is higher than the other two monitoring sites; this is expected given the difference in pollutants measured at each site.

- Twenty-three pollutants failed at least one screen for NBIL; 46 percent of concentrations for these 23 pollutants were greater than their associated risk screening value (or failed screens).

- Twelve pollutants contributed to 95 percent of failed screens for NBIL and therefore were identified as pollutants of interest for this site. These 12 include two carbonyl compounds, five VOCs, one PM_{10} metal, and four PAHs.

- NBIL failed the third highest number of screens (1,023) among NMP sites, as shown in Table 4-9, and had the highest number of pollutants whose concentrations failed screens (23). However, the failure rate for NBIL, when incorporating all pollutants with screening values, is relatively low, at nearly 20 percent. This is due primarily to the relatively large number of pollutants sampled for at this site. NBIL is one of only two NMP sites sampling five pollutant groups and one of only two sites to sample with both the TO-15 and SNMOC methods. As described in Section 3.2, if a pollutant was measured by both the TO-15 and SNMOC methods at the same site, the TO-15 results were used for the risk-based screening process. As NBIL sampled both VOCs (TO-15) and SNMOCs, the TO-15 results were used for the 12 pollutants these methods have in common.

- Fourteen pollutants failed screens for SPIL; 59 percent of concentrations for these 14 pollutants were greater than their associated risk screening value (or failed screens).

- Eight pollutants contributed to 95 percent of failed screens for SPIL and therefore were identified as pollutants of interest for this site. These eight include two carbonyl compounds and six VOCs. SPIL is the only NMP site with trichloroethylene as a pollutant of interest. This was also true in the 2014 NMP report.

- Ten pollutants failed screens for ROIL; 75 percent of concentrations for these 10 pollutants were greater than their associated risk screening value (or failed screens).

- Six pollutants contributed to 95 percent of failed screens for ROIL and therefore were identified as pollutants of interest for this site. These six include two carbonyl compounds and four VOCs.

- The Illinois monitoring sites have six pollutants of interest in common: two carbonyl compounds (acetaldehyde and formaldehyde) and four VOCs (benzene, 1,3-butadiene, carbon tetrachloride, 1,2-dichloroethane). Of these, acetaldehyde, benzene, carbon tetrachloride, and formaldehyde failed 100 percent of screens for each site.

For each of the data analyses described in the remaining sections, the focus is on the site-specific pollutants of interest identified via the risk-based screening process, as described in Section 3.4.2.

10.3 Concentrations

This section presents various concentration averages used to characterize air toxics concentration levels at the Illinois monitoring sites. Where applicable, the following calculations and data analyses were performed for each of the site-specific pollutants of interest:

- Time period-based concentration averages (quarterly and annual) are provided for each monitoring site for each year.
- The range of measurements and annual concentration averages are presented graphically for each site to illustrate how the site's concentrations compare to the program-level averages, as presented in Section 4.1.
- Concentration averages and other statistical metrics for 2015, 2016, and from previous years of monitoring are presented in order to characterize concentration trends at each site.

Each data analysis is performed where the applicable criteria are met (as specified in the appropriate sections discussed below) and is limited to the site-specific pollutants of interest. However, site-specific statistical summaries for all pollutants sampled for at NBIL, SPIL, and ROIL are provided in Appendices J, K, and M through P.

10.3.1 2015 and 2016 Concentration Averages

Quarterly and annual concentration averages for 2015 and 2016 were calculated for the pollutants of interest for each Illinois site, as described in Section 3.1. The *quarterly average concentration* of a particular pollutant is simply the average concentration of the preprocessed daily measurements over a given calendar quarter. Quarterly average concentrations include the substitution of zeros for all non-detects. A site must have a minimum of 75 percent valid samples compared to the total number of samples possible within a given calendar quarter for a quarterly average to be calculated. An *annual average concentration* includes all measured detections and substituted zeros for non-detects for an entire year of sampling. Annual averages were calculated for pollutants where three valid quarterly averages could be calculated for a given year and where method completeness was greater than or equal to 85 percent, as presented in Section 2.4. Quarterly and annual average concentrations for the pollutants of interest for the Illinois monitoring sites are presented in Table 10-3, where applicable. Note that concentrations of the PAHs and metals for NBIL are presented in ng/m^3 for ease of viewing. Also note that if a pollutant was not detected in a given calendar quarter, the quarterly average simply reflects "0" because only zeros substituted for non-detects were factored into the quarterly average concentration.

Table 10-3. Quarterly and Annual Average Concentrations of the Pollutants of Interest for the Illinois Monitoring Sites

Pollutant	2015						2016					
	# of Detects/ # >MDL/ # Samples	Q1 Avg (µg/m³)	Q2 Avg (µg/m³)	Q3 Avg (µg/m³)	Q4 Avg (µg/m³)	Annual Average (µg/m³)	# of Detects/ # >MDL/ # Samples	Q1 Avg (µg/m³)	Q2 Avg (µg/m³)	Q3 Avg (µg/m³)	Q4 Avg (µg/m³)	Annual Average (µg/m³)
Northbrook, Illinois - NBIL												
Acetaldehyde	57/57/57	1.16 ± 0.20	1.17 ± 0.28	1.68 ± 0.26	1.71 ± 0.46	1.42 ± 0.16	59/59/59	2.18 ± 0.55	1.26 ± 0.35	1.49 ± 0.32	0.96 ± 0.29	1.47 ± 0.21
Benzene	54/54/54	0.59 ± 0.05	0.42 ± 0.10	0.61 ± 0.16	NA	0.52 ± 0.06	59/59/59	0.49 ± 0.09	0.36 ± 0.08	0.47 ± 0.09	0.43 ± 0.09	0.43 ± 0.04
1,3-Butadiene	51/32/54	0.04 ± 0.01	0.03 ± 0.01	0.05 ± 0.02	NA	0.04 ± 0.01	56/9/59	0.03 ± 0.01	0.04 ± 0.01	0.04 ± 0.01	0.04 ± 0.01	0.04 ± 0.01
Carbon Tetrachloride	54/54/54	0.59 ± 0.08	0.63 ± 0.02	0.68 ± 0.04	NA	0.63 ± 0.03	59/59/59	0.51 ± 0.05	0.69 ± 0.05	0.50 ± 0.11	0.54 ± 0.06	0.56 ± 0.04
p-Dichlorobenzene	27/8/54	0.01 ± 0.01	0.04 ± 0.03	0.34 ± 0.39	NA	0.13 ± 0.11	23/3/59	<0.01 ± 0.01	0.05 ± 0.03	0.06 ± 0.03	0.02 ± 0.02	0.03 ± 0.01
1,2-Dichloroethane	53/49/54	0.08 ± <0.01	0.08 ± 0.01	0.06 ± 0.01	NA	0.07 ± <0.01	50/50/59	0.08 ± 0.02	0.09 ± 0.01	0.06 ± 0.02	0.04 ± 0.02	0.07 ± 0.01
Formaldehyde	57/57/57	1.74 ± 0.27	1.87 ± 0.39	3.04 ± 0.50	1.38 ± 0.31	2.03 ± 0.25	59/59/59	1.41 ± 0.39	2.31 ± 0.72	3.53 ± 0.97	1.28 ± 0.23	2.16 ± 0.39
Acenaphthene [a]	55/55/60	3.20 ± 2.52	23.72 ± 14.01	39.75 ± 11.73	3.23 ± 1.20	17.48 ± 5.87	55/55/56	2.82 ± 1.07	19.49 ± 11.80	46.29 ± 11.43	5.03 ± 3.05	18.93 ± 6.15
Arsenic (PM_{10})[a]	56/56/56	0.55 ± 0.12	0.83 ± 0.45	1.55 ± 1.01	0.87 ± 0.25	0.94 ± 0.27	57/57/57	NA	1.08 ± 0.27	1.00 ± 0.21	0.75 ± 0.23	0.87 ± 0.13
Fluoranthene[a]	60/60/60	2.21 ± 1.06	10.87 ± 6.30	20.29 ± 6.57	1.91 ± 0.59	8.82 ± 2.90	56/56/56	1.94 ± 0.54	13.65 ± 8.86	26.45 ± 7.57	2.51 ± 1.12	11.38 ± 3.85
Fluorene[a]	53/53/60	3.56 ± 2.44	21.43 ± 12.95	37.23 ± 10.61	2.87 ± 1.15	16.27 ± 5.41	51/51/56	2.29 ± 1.14	20.78 ± 12.35	46.67 ± 12.88	4.98 ± 2.39	19.19 ± 6.42
Naphthalene[a]	60/60/60	43.62 ± 14.02	97.32 ± 40.71	179.35 ± 54.50	36.97 ± 9.24	89.32 ± 22.07	56/56/56	47.67 ± 17.25	79.44 ± 33.74	145.74 ± 39.92	41.07 ± 11.5	79.55 ± 17.47

[a] Average concentrations provided for the pollutants below the blue line are presented in ng/m³ for ease of viewing.
NA = Not available because the criteria for calculating a quarterly and/or annual average were not met.
NS = Sampling was not conducted during this time.

Table 10-3. Quarterly and Annual Average Concentrations of the Pollutants of Interest for the Illinois Monitoring Sites (Continued)

Pollutant	2015						2016					
	# of Detects/ # >MDL/ # Samples	Q1 Avg (µg/m³)	Q2 Avg (µg/m³)	Q3 Avg (µg/m³)	Q4 Avg (µg/m³)	Annual Average (µg/m³)	# of Detects/ # >MDL/ # Samples	Q1 Avg (µg/m³)	Q2 Avg (µg/m³)	Q3 Avg (µg/m³)	Q4 Avg (µg/m³)	Annual Average (µg/m³)
Schiller Park, Illinois - SPIL												
Acetaldehyde	61/61/61	2.49 ± 0.35	1.91 ± 0.35	2.54 ± 0.34	2.71 ± 1.87	2.43 ± 0.52	57/57/57	4.07 ± 1.78	1.71 ± 0.41	1.55 ± 0.27	2.17 ± 1.04	2.45 ± 0.61
Benzene	60/60/60	0.78 ± 0.10	0.77 ± 0.35	0.68 ± 0.25	0.62 ± 0.12	0.71 ± 0.10	58/58/58	0.66 ± 0.09	0.58 ± 0.08	0.60 ± 0.12	0.68 ± 0.15	0.63 ± 0.05
1,3-Butadiene	60/59/60	0.12 ± 0.04	0.14 ± 0.08	0.12 ± 0.04	0.11 ± 0.04	0.12 ± 0.02	58/53/58	0.12 ± 0.03	0.12 ± 0.02	0.10 ± 0.02	0.11 ± 0.03	0.11 ± 0.01
Carbon Tetrachloride	60/60/60	0.61 ± 0.05	0.62 ± 0.04	0.66 ± 0.04	0.59 ± 0.05	0.62 ± 0.02	58/58/58	0.58 ± 0.05	0.68 ± 0.04	0.61 ± 0.07	0.62 ± 0.05	0.62 ± 0.03
p-Dichlorobenzene	25/1/60	0.02 ± 0.02	0.04 ± 0.03	0.05 ± 0.03	0.02 ± 0.02	0.03 ± 0.01	25/3/58	0.02 ± 0.01	0.04 ± 0.02	0.06 ± 0.04	0.02 ± 0.03	0.03 ± 0.01
1,2-Dichloroethane	60/54/60	0.08 ± 0.01	0.08 ± 0.01	0.06 ± 0.01	0.08 ± 0.01	0.08 ± <0.01	54/53/58	0.09 ± 0.01	0.09 ± 0.01	0.06 ± 0.02	0.07 ± 0.01	0.07 ± 0.01
Formaldehyde	61/61/61	3.02 ± 0.33	3.35 ± 0.59	5.13 ± 0.79	3.85 ± 1.23	3.85 ± 0.45	57/57/57	4.43 ± 1.39	3.22 ± 0.58	3.48 ± 0.50	2.87 ± 0.73	3.54 ± 0.47
Trichloroethylene	42/35/60	0.09 ± 0.06	0.31 ± 0.37	0.57 ± 0.57	0.19 ± 0.12	0.29 ± 0.16	48/36/58	0.20 ± 0.17	0.30 ± 0.19	0.60 ± 0.43	0.19 ± 0.17	0.32 ± 0.13
Roxana, Illinois - ROIL												
Acetaldehyde	33/33/33	1.71 ± 0.41	2.21 ± 0.33	NA	NS	NS	NS	NS	NS	NS	NS	NS
Benzene	32/32/32	0.95 ± 0.18	1.48 ± 0.61	NA	NS	NS	NS	NS	NS	NS	NS	NS
1,3-Butadiene	30/25/32	0.06 ± 0.02	0.04 ± 0.01	NA	NS	NS	NS	NS	NS	NS	NS	NS
Carbon Tetrachloride	32/32/32	0.61 ± 0.04	0.62 ± 0.05	NA	NS	NS	NS	NS	NS	NS	NS	NS
1,2-Dichloroethane	31/30/32	0.09 ± 0.01	0.09 ± 0.01	NA	NS	NS	NS	NS	NS	NS	NS	NS
Formaldehyde	33/33/33	1.94 ± 0.39	4.15 ± 1.04	NA	NS	NS	NS	NS	NS	NS	NS	NS

[a] Average concentrations provided for the pollutants below the blue line are presented in ng/m³ for ease of viewing.
NA = Not available because the criteria for calculating a quarterly and/or annual average were not met.
NS = Sampling was not conducted during this time.

Observations for NBIL from Table 10-3 include the following:

- The pollutants with the highest annual average concentrations for both years are formaldehyde and acetaldehyde. The annual average concentrations for the remaining pollutants of interest are less than 1 $\mu g/m^3$, with carbon tetrachloride as the next highest.

- Formaldehyde concentrations measured at NBIL range from 0.406 $\mu g/m^3$ to 7.11 $\mu g/m^3$. For 2015, the third quarter average concentration of formaldehyde (3.05 ± 0.50 $\mu g/m^3$) is significantly higher than the other quarterly averages, which are all less than 2 $\mu g/m^3$. A review of the data shows that all but one of the 10 formaldehyde concentrations greater than or equal to 3 $\mu g/m^3$ in 2015 were measured between July and September (with the exception measured in May). For 2016, the third quarter average (3.53 ± 0.97 $\mu g/m^3$) is also the highest quarterly average concentration, but the confidence interval associated with this average is relatively large, indicating considerable variability in the measurements. This is also true for the second quarter average for 2016 (2.31 ± 0.72 $\mu g/m^3$). Twelve formaldehyde concentrations greater than or equal to 3 $\mu g/m^3$ were measured in 2016, with four measured during the second quarter and eight measured during the third quarter of 2016.

- Acetaldehyde concentrations measured at NBIL range from 0.473 $\mu g/m^3$ to 3.95 $\mu g/m^3$. Quarterly average concentrations of acetaldehyde range from 0.96 ± 0.29 $\mu g/m^3$ (fourth quarter 2016) to 2.18 ± 0.55 $\mu g/m^3$ (first quarter 2016). The three highest acetaldehyde concentrations were measured at NBIL during the first quarter of 2016; further, six of the eight acetaldehyde concentrations greater than 2.5 $\mu g/m^3$ in 2016 were measured during the first quarter of the year (with one each measured during the second and third quarters), explaining the relatively high quarterly average acetaldehyde concentration shown in Table 10-3. By comparison, three acetaldehyde concentrations greater than 2.5 $\mu g/m^3$ were measured in 2015.

- Fourth quarter average concentrations for 2015 for the VOCs in Table 10-3 could not be calculated because there were too many invalid samples (due to varying sampling issues) during this quarter to meet the 75 percent criterion. Carbon tetrachloride and benzene have the highest annual average concentrations among the VOCs in Table 10-3.

- Concentrations of carbon tetrachloride measured at NBIL range from 0.240 $\mu g/m^3$ to 0.832 $\mu g/m^3$. Even though six concentrations measured in 2016 are greater than the maximum carbon tetrachloride concentration measured in 2015, including all four concentrations greater than 0.8 $\mu g/m^3$, the annual average for 2015 is greater than the annual average for 2016. This can be explained by reviewing the measurements at the lower end of the concentration range. Three carbon tetrachloride concentrations less than 0.5 $\mu g/m^3$ were measured in 2015 compared to 21 in 2016.

- Concentrations of benzene measured at NBIL range from 0.16 $\mu g/m^3$ to 1.20 $\mu g/m^3$. Only two benzene concentrations greater than 1 $\mu g/m^3$ were measured at NBIL, both of which were measured during the third quarter of 2015, which is the second fewest

among NMP sites sampling benzene over the full 2-year period. NBIL's annual average concentration of benzene for 2016 is the fifth lowest across the program.

- Concentrations of *p*-dichlorobenzene measured at NBIL range from 0.0361 µg/m^3 to 2.78 µg/m^3 plus 63 non-detects. The third quarter average concentration of *p*-dichlorobenzene for 2015 is an order of magnitude higher than the other quarterly average shown and has a confidence interval greater than the average itself (0.34 ± 0.39 µg/m^3). This indicates the likely presence of outlier(s). A review of the data shows that the maximum *p*-dichlorobenzene concentration measured at NBIL on September 21, 2015 (2.78 µg/m^3) is the maximum *p*-dichlorobenzene concentration measured across the program. The next highest *p*-dichlorobenzene concentration measured at NBIL is one-third the magnitude (0.837 µg/m^3), but even this concentration is among the highest across the program. NBIL is one of five NMP sites with at least one *p*-dichlorobenzene concentration greater than 0.5 µg/m^3 (NBIL has four, second only to S4MO, which as 10), all of which were measured during the third or fourth quarters of 2015.

- Arsenic is the only PM_{10} metal identified as a pollutant of interest for NBIL. Arsenic concentrations measured at NBIL range from 0.076 ng/m^3 to 7.18 ng/m^3. Although the 2015 and 2016 annual average concentrations of arsenic are fairly similar to each other, the confidence interval for 2015 is more than twice the confidence interval for 2016. The maximum arsenic concentration was measured at NBIL on July 5, 2015 and is more than twice the next highest concentration measured at this site, and the second highest measured across the program. This is reflected in the third quarter average concentration for 2015 (1.55 ± 1.01 ng/m^3). A review of the data shows that concentrations measured during the third quarter of 2015 were higher overall compared to other calendar quarters. The third quarter of 2015 is the only calendar quarter within which an arsenic concentration less than 0.5 ng/m^3 was not measured; among the other calendar quarters, the number of arsenic concentrations less than 0.5 ng/m^3 ranged from as few as one (third quarter of 2016) to as many as seven (both the second quarter of 2015 and first quarter of 2016). Even if the maximum concentration was excluded, the third quarter average for 2015 would still be the highest quarterly average concentration of arsenic. A quarterly average concentration for first quarter of 2016 could not be calculated because there were too many invalid samples (many for run time issues) to meet the 75 percent criterion.

- Of the PAHs, naphthalene has the highest annual average concentrations shown. Naphthalene concentrations measured at NBIL span three orders of magnitude, ranging from 0.446 µg/m^3 to 403 ng/m^3. These are both the minimum and maximum naphthalene concentrations measured across the program. Quarterly average concentrations of naphthalene vary considerably, from 36.97 ± 9.24 ng/m^3 (fourth quarter of 2015) to 179.35 ± 54.50 ng/m^3 (third quarter of 2015). The maximum naphthalene concentration across the program has been measured at NBIL for the last several years. Based on the quarterly averages shown, concentrations of naphthalene appear higher during the warmer months of the year and exhibit the most variability. All but one of the 17 naphthalene concentrations greater than 150 ng/m^3 measured at NBIL were measured between May and September of any given year (with the exception measured in April). Conversely, all but two of the 23 naphthalene concentrations less than 25 ng/m^3 were measured outside these five months.

- Some of the highest concentrations of acenaphthene, fluorene, and fluoranthene measured across the program were also measured at NBIL. Concentrations of acenaphthene measured at NBIL range from 0.338 ng/m^3 to 103 ng/m^3, plus six non-detects, accounting for 12 of the 15 highest acenaphthene measurements across the program (those greater than 50 ng/m^3). Concentrations of fluorene measured at NBIL range from 0.675 ng/m^3 to 96 ng/m^3, plus 12 non-detects; although the maximum fluorene concentration across the program was not measured at NBIL, concentrations measured at NBIL account for the next 15 highest measurements across the program. Concentrations of fluoranthene range from 0.403 ng/m^3 to 57.3 ng/m^3, with concentrations measured at NBIL accounting for all but one of the 11 fluoranthene concentrations greater than 30 ng/m^3 across the program. Concentrations of these PAH pollutants of interest also tended to be measured during the warmer months of the year and exhibit a relatively large amount of variability, based on the quarterly average concentrations shown and their associated confidence intervals. Many of the higher PAH concentrations were measured on the same sample days. For instance, the highest fluorene and acenaphthene concentrations were measured at NBIL on June 23, 2015 and the second highest fluorene and acenaphthene concentrations were measured at NBIL on August 10, 2016 (along with the third highest naphthalene concentration and fourth highest fluoranthene concentration).

Observations for SPIL from Table 10-3 include the following:

- The pollutants with the highest annual average concentrations for SPIL are formaldehyde and acetaldehyde (for both years). These are the only pollutants of interest with annual average concentrations greater than 1 µg/m^3. Of the VOCs, benzene and carbon tetrachloride have the highest annual average concentrations for SPIL.

- Concentrations of formaldehyde measured at SPIL range from 1.45 µg/m^3 to 12.3 µg/m^3. The three highest formaldehyde concentrations were measured between December 2015 and February 2016, explaining, at least in part, the relatively large confidence intervals associated with the fourth quarter average of 2015 and the first quarter average of 2016 (these quarterly averages have confidence intervals greater than 1.00). Formaldehyde concentrations greater than 5 µg/m^3 were not measured at SPIL prior to the third quarter of 2015. Of the 16 formaldehyde concentrations greater than 5 µg/m^3 measured at SPIL, 13 were measured between July 2015 and February 2016, with one measured during each of the other calendar quarters in 2016. With the exception of the third quarter average for 2015 and the first quarter average for 2016, the quarterly average concentrations of formaldehyde vary by less than 1 µg/m^3.

- Concentrations of acetaldehyde measured at SPIL range from 0.793 µg/m^3 to 17.1 µg/m^3, which is the second highest acetaldehyde concentration measured across the program. SPIL is one of three NMP sites at which an acetaldehyde concentration greater than 10 µg/m^3 was measured; of the six acetaldehyde concentrations greater than 10 µg/m^3, two were measured at SPIL. These two concentrations were measured on December 2, 2015 and February 12, 2016, the same days the maximum formaldehyde concentrations were measured (although the acetaldehyde concentrations were higher). Acetaldehyde concentrations greater than 4 µg/m^3 were measured between December 2015 and February 2016 (five) or in December 2016

(two). The effect of these measurements can be seen in the confidence intervals for the fourth quarter average of 2015 and the first and fourth quarter averages of 2016.

- Quarterly average concentrations for several of the VOCs, including 1,3-butadiene, carbon tetrachloride, *p*-dichlorobenzene, and 1,2-dichloroethane, did not vary much across years.

- Concentrations of benzene appear higher at SPIL in 2015 than in 2016, particularly for the first half of 2015, though the difference is not statistically significant. Twice the number of benzene concentrations greater than 1 $\mu g/m^3$ were measured in 2015 (six) compared to 2016 (three), with the three highest measured in 2015.

- Although the two annual average concentrations of trichloroethylene are similar to each other, the quarterly average concentrations vary significantly, from 0.09 ± 0.06 $\mu g/m^3$ (first quarter 2015) to 0.60 ± 0.43 $\mu g/m^3$ (third quarter 2016). Each of the quarterly average concentrations shown has a relatively large confidence interval, including two greater than or equal to the averages themselves. This is also true for the annual average concentrations of this pollutant. A review of the data shows that trichloroethylene was detected in 76 percent of the samples collected at SPIL, with measured detections ranging from 0.0323 $\mu g/m^3$ to 4.02 $\mu g/m^3$. Eleven of the 14 trichloroethylene concentrations greater than 1 $\mu g/m^3$ measured across the program were measured at SPIL. Interestingly, NBIL is the only NMP site at which a trichloroethylene concentration greater than the maximum concentration measured at SPIL was measured. (Trichloroethylene was not identified as a pollutant of interest for NBIL.) Nineteen of the 23 highest trichloroethylene concentrations (those greater than 0.5 $\mu g/m^3$) across the program were measured at SPIL. SPIL is the only NMP site for which trichloroethylene is a pollutant of interest. Similar observations were also made in the 2011, 2012, 2013, and 2014 NMP reports.

- The annual averages for acetaldehyde and formaldehyde for SPIL for both years are significantly higher than the annual averages for these compounds for NBIL. This is also true for 1,3-butadiene and benzene.

Observations for ROIL from Table 10-3 include the following:

- Sampling at ROIL was discontinued at the end of July 2015, ending a four-year monitoring effort at this location. Due to the discontinuation of sampling, quarterly average concentration could be calculated for the first and second quarters of 2015 only and no annual averages are provided. However, statistical summaries for the entire period of sampling in 2015 are provided in Appendices J and M.

- The pollutants with the highest quarterly average concentrations are formaldehyde, acetaldehyde, and benzene. For each of these pollutants, the second quarter average concentration is greater than the first quarter average, particularly for formaldehyde.

- The second quarter average concentration of formaldehyde is significantly higher than the first quarter average. A review of the data shows that formaldehyde concentrations measured at ROIL range from 1.20 $\mu g/m^3$ to 9.91 $\mu g/m^3$, with 17 of the 18 formaldehyde concentrations greater than 3 $\mu g/m^3$ measured at ROIL after April 1st (including all five concentrations measured in July). At the other end of the

concentration range, none of the 10 formaldehyde concentrations less than 2 µg/m^3 were measured outside the first quarter of 2015.

- Concentrations of acetaldehyde also appear higher during the second quarter, although the difference among the quarterly averages is considerably less. While acetaldehyde concentrations greater than 2 µg/m^3 were measured during both calendar quarters, most of them (10 of 13) were measured after April 1st, including three in July. Conversely, the six lowest acetaldehyde concentrations were measured at ROIL during the first quarter of 2015.

- Concentrations of benzene also appear higher during the second quarter and, similar to formaldehyde, the confidence interval for the second quarter average concentration is considerably larger than the confidence interval shown for the first quarter average. Benzene concentrations measured at ROIL span an order of magnitude, ranging from 0.349 µg/m^3 to 3.94 µg/m^3, which is the 12th highest benzene concentration measured at an NMP site in 2015 and 2016. The four highest benzene concentrations (those greater than 2 µg/m^3) were measured at ROIL after the first quarter, with one measured in April, two in May, and one in July. However, all three benzene concentrations less than 0.5 µg/m^3 were also measured after the first quarter.

- For the remaining pollutants of interest, the first quarter average for 2015 is similar to the second quarter average for 2015.

Tables 4-10 through 4-13 present the NMP sites with the 10 highest annual average concentrations for each of the program-level pollutants of interest. Observations for NBIL and SPIL from those tables include the following:

- The Chicago monitoring sites appear in Tables 4-10 through 4-13 a total of 15 times, with NBIL appearing 10 times and SPIL appearing five times.

- Table 4-10 shows that annual average concentrations of 1,3-butadiene for SPIL rank eighth (2015) and 10th (2016) among NMP sites sampling this pollutant. NBIL also appears for its annual average concentration of *p*-dichlorobenzene for 2015, ranking seventh (the annual average for 2016 ranks considerably lower). NBIL's annual average concentration of hexachloro-1,3-butadiene (for 2016) ranks 10th among NMP sites sampling this pollutant, although the annual averages for this pollutant do not vary considerably.

- SPIL appears in Table 4-11 for both of its annual average concentrations of acetaldehyde, ranking eighth (2016) and ninth (2015). SPIL also ranks ninth for its 2015 annual average concentration of formaldehyde, with the annual average for 2016 outside the top 10.

- NBIL's annual average concentrations of acenaphthene and fluorene rank highest among NMP sites sampling PAHs, as shown in Table 4-12. The confidence intervals associated with NBIL's annual averages for these PAHs are the largest among the averages shown, a reflection of the variability within the measurements. NBIL's annual average concentrations of naphthalene also appear in Table 4-12, ranking sixth

(2015) and seventh (2016) highest, and also have the largest confidence intervals shown.

- The annual average concentrations of arsenic for NBIL rank fourth (2015) and eighth (2016) highest among NMP sites sampling PM_{10} metals, as shown in Table 4-13.

10.3.2 Concentration Comparison

In order to better illustrate how each site's annual average concentrations compare to the program-level averages, a site-specific box plot was created for each of the site-specific pollutants of interest, where applicable. Thus, box plots were created for the pollutants listed in Table 10-3 for NBIL, SPIL, and ROIL. Figures 10-6 through 10-18 overlay the sites' minimum, annual average, and maximum concentrations for each year onto the program-level minimum, first quartile, median, average, third quartile, and maximum concentrations, as described in Section 3.4.2.1, and are discussed below. If an annual average concentration could not be calculated, the range of concentrations is still provided in the figures that follow.

Figure 10-6. Program vs. Site-Specific Average Acenaphthene Concentrations

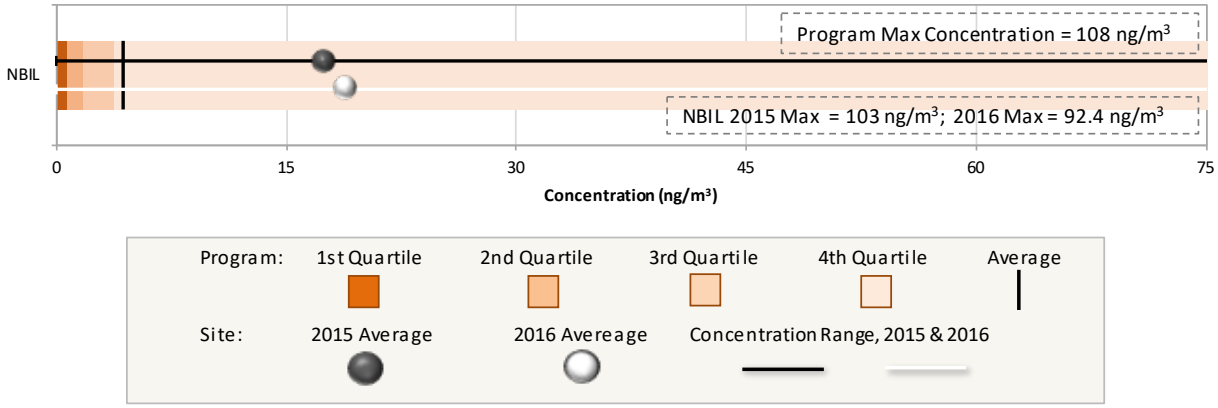


Figure 10-6 presents the box plot for acenaphthene for NBIL and shows the following:

- NBIL is the only Illinois site to sample PAHs under the NMP in 2015 and 2016. The program-level maximum concentration (108 ng/m^3) of acenaphthene is not shown directly on the box plot because the scale of the box plot would be too large to readily observe data points at the lower end of the concentration range. Thus, the scale has been reduced.

- The maximum acenaphthene concentrations measured each year at NBIL exceed the scale of the box plot and thus, are also provided on the box plot. Two additional acenaphthene concentrations measured at NBIL in 2015 exceed the scale of the box plot. Four NMP sites have individual acenaphthene concentrations greater than 40 ng/m^3, with concentrations measured at NBIL accounting for more than half of them (19 out of 31).

- NBIL's annual average concentrations of acenaphthene are both more than four times the program-level average concentration. More than half of NBIL's individual acenaphthene measurements are greater than the program-level average concentration (4.36 ng/m^3). Note that the program-level average is greater than the program-level third quartile, an indication that the measurements at the upper end of the concentration range are driving the program-level average upward.

Figure 10-7. Program vs. Site-Specific Average Acetaldehyde Concentrations

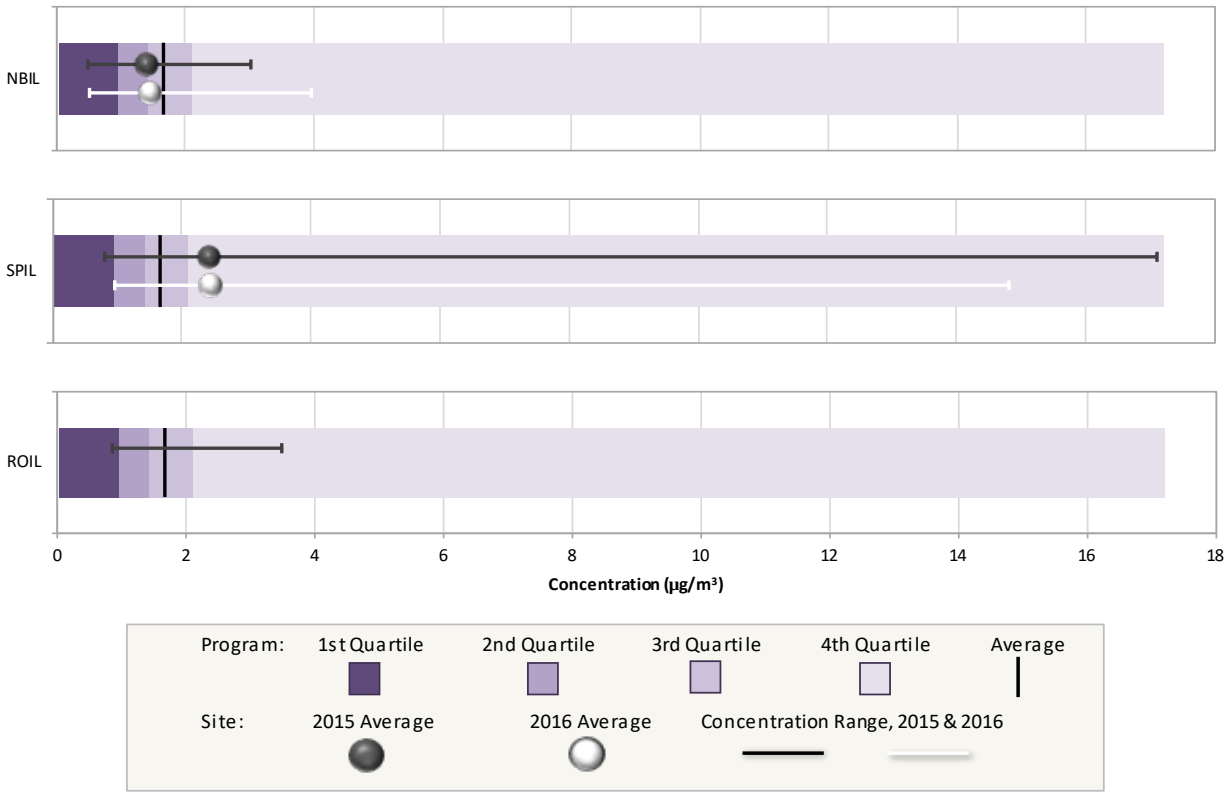


Figure 10-7 presents the box plots for acetaldehyde for all three sites and shows the following:

- The range of acetaldehyde concentrations measured is largest for SPIL and smallest for NBIL. The maximum acetaldehyde concentration measured at SPIL in 2015 is only slightly less than the maximum acetaldehyde concentration measured across the program. The maximum acetaldehyde concentration measured at SPIL in 2016 is also among the highest measured across the program. The minimum concentration measured at SPIL in 2016 is greater than the program-level first quartile. By comparison, only 11 percent of individual acetaldehyde concentrations measured at NBIL are greater than the annual averages for SPIL.

- Both annual averages for SPIL greater than the program-level average and third quartile. The annual average concentrations of acetaldehyde for NBIL are a full 1 µg/m^3 less than the annual averages for SPIL and are less than the program-level average concentration.

- The range of acetaldehyde concentrations measured at ROIL is more similar to the range measured at NBIL than SPIL, although the minimum concentration measured at ROIL is just less than the program-level first quartile.

- Sampling at ROIL under the NMP was discontinued at the end of July 2015.

Figure 10-8. Program vs. Site-Specific Average Arsenic (PM_{10}) Concentrations

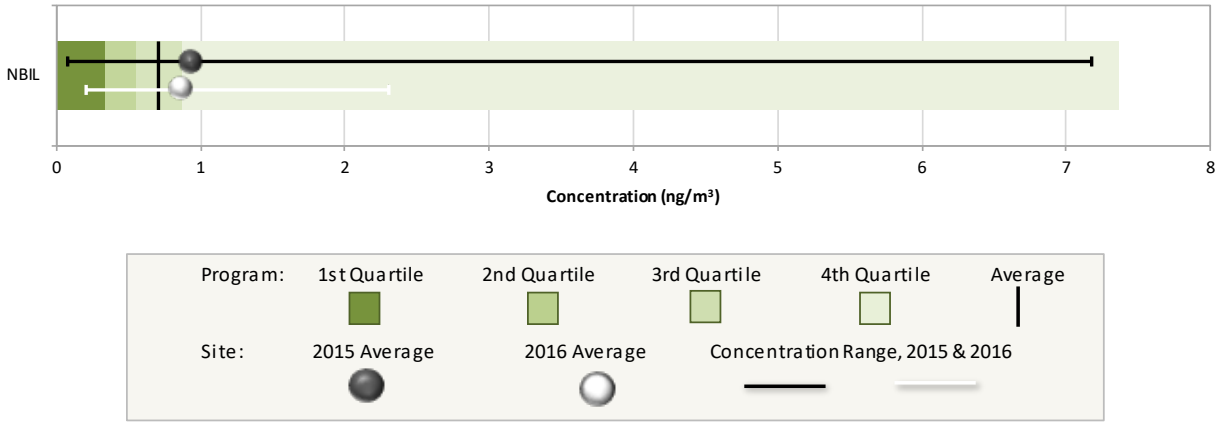


Figure 10-8 presents the box plot for arsenic (PM_{10}) for NBIL and shows the following:

- NBIL is the only Illinois site to sample PM_{10} metals under the NMP in 2015 and 2016.

- The range of arsenic concentrations measured at NBIL in 2015 is considerably larger than the range measured in 2016; the maximum arsenic concentration measured at NBIL in 2015 is more than three times greater than the maximum arsenic concentration measured at NBIL in 2016. This measurement is also the second highest arsenic concentration measured across the program.

- Despite the differences in the range of concentrations, the annual average concentrations of arsenic for NBIL are fairly similar; both annual averages are greater than the program-level average (0.70 ng/m^3), with the annual average for 2015 also greater than the program-level third quartile.

- Non-detects of arsenic were not measured at NBIL, although a few were measured across the program.

Figure 10-9. Program vs. Site-Specific Average Benzene Concentrations

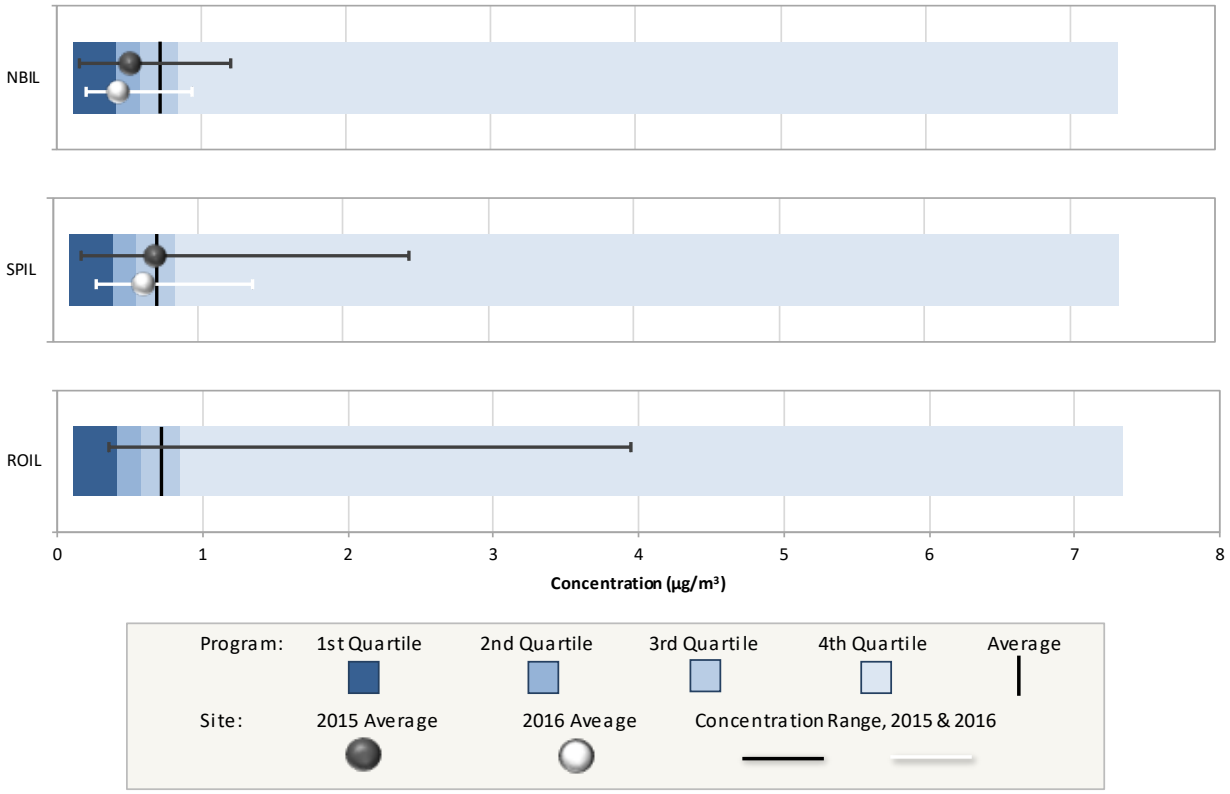


Figure 10-9 presents the box plots for benzene for all three sites and shows the following:

- Despite the shortened sampling duration, the range of benzene concentrations measured was larger for ROIL than the two Chicago sites. Twice the number of benzene concentrations greater than 2 µg/m^3 were measured at ROIL (four) than SPIL (two), with none measured at NBIL. Among the 27 benzene concentrations greater than 1 µg/m^3 measured at these sites, only two were measured at NBIL, compared to nine at SPIL and 16 at ROIL.

- Both of NBIL's annual average benzene concentrations are less than the program-level median concentration, with the annual average for 2016 similar to the program-level first quartile and the fifth lowest among NMP sites sampling this pollutant.

- SPIL's annual average benzene concentrations are both greater than the program-level median concentration, with the annual average for 2015 similar to the program-level average concentration.

Figure 10-10. Program vs. Site-Specific Average 1,3-Butadiene Concentrations

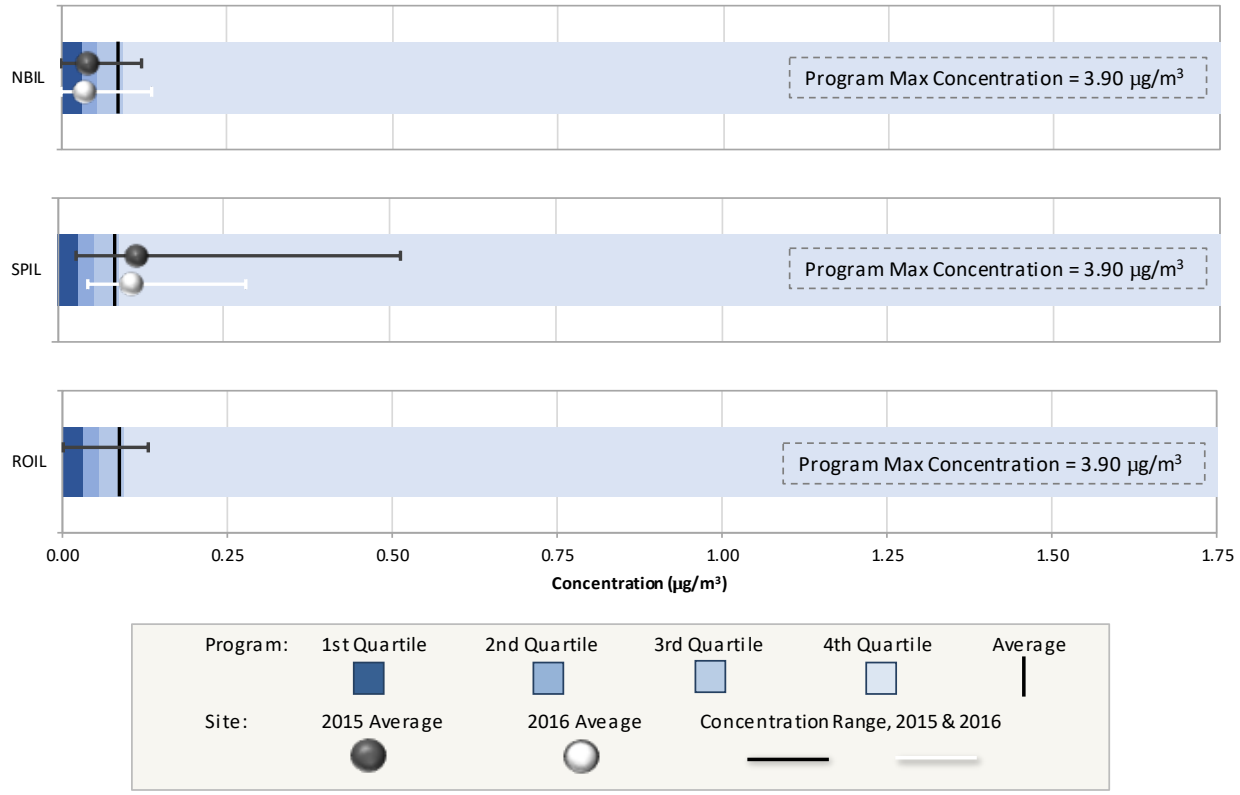


Figure 10-10 presents the box plots for 1,3-butadiene for all three sites and shows the following:

- The program-level maximum 1,3-butadiene concentration (3.90 µg/m^3) is not shown directly on the box plots as the scale has been reduced to allow for the observation of data points at the lower end of the concentration range. Only one 1,3-butatdiene concentration measured at the Illinois sites is greater than one-tenth of the program-level maximum concentration.

- The range of 1,3-butadiene concentrations measured at NBIL is similar to the range measured at ROIL, with a few non-detects measured at these two sites. The maximum 1,3-butadiene concentrations measured at these two sites are fairly similar to each other.

- The range of 1,3-butadiene concentrations measured at SPIL in 2015 is more than twice the range measured in 2016. Despite this, the annual average concentrations for both years are similar to each other, with both greater than the program-level average concentration and third quartile. The annual average 1,3-butadiene concentrations for SPIL are more than twice the annual averages for NBIL.

Figure 10-11. Program vs. Site-Specific Average Carbon Tetrachloride Concentrations

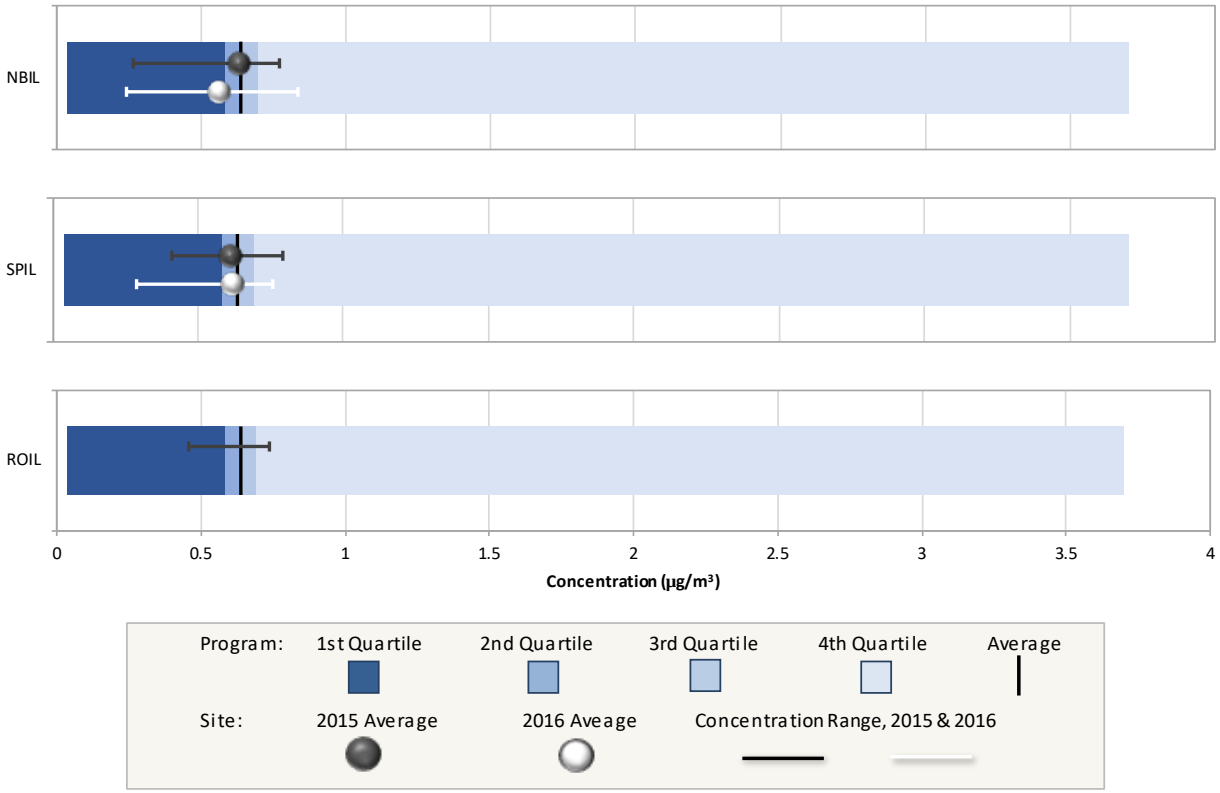


Figure 10-11 presents the box plots for carbon tetrachloride for all three sites and shows the following:

- Less than 0.6 µg/m^3 separates the minimum and maximum carbon tetrachloride concentrations measured at the Illinois sites, with both the minimum and maximum concentrations measured at NBIL.

- The program-level average and median concentrations are similar to each other and are plotted nearly on top of one another in Figure 10-11. The annual average concentrations of carbon tetrachloride for SPIL are similar for 2015 and 2016, both of which are just less than the program-level median and average concentrations. For NBIL, the 2015 annual average concentration is greater than the annual average for 2016, with the 2015 annual average similar to the program-level average and median concentrations and the 2016 annual average just less than the program-level first quartile.

Figure 10-12. Program vs. Site-Specific Average *p*-Dichlorobenzene Concentrations

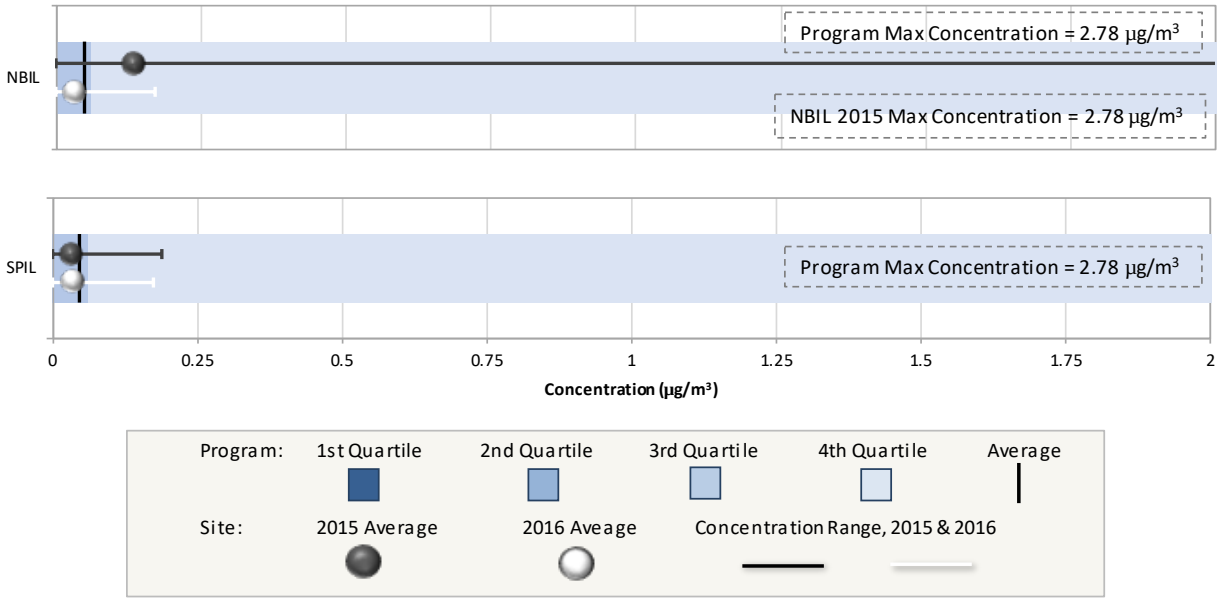


Figure 10-12 presents the box plots for *p*-dichlorobenzene for the Chicago sites and shows the following:

- The program-level maximum *p*-dichlorobenzene concentration (2.78 µg/m^3) is not shown directly on the box plots as the scale has been reduced. Note that the program-level first and second quartiles for *p*-dichlorobenzene are both zero, and therefore not visible on the box plots. This pollutant has a 43 percent detection rate across the program.

- The maximum concentration of *p*-dichlorobenzene measured at NBIL in 2015 is the maximum concentration measured across the program. While this is the only *p*-dichlorobenzene concentration greater than 1 µg/m^3 measured at NBIL, six additional *p*-dichlorobenzene concentrations measured in 2015 are greater than the maximum concentration measured at this site in 2016. The maximum concentration measured at NBIL in 2016 is similar to the maximum concentrations measured each year at SPIL.

- NBIL's 2016 annual average concentration of *p*-dichlorobenzene is similar to both of SPIL's annual average concentrations, all three of which are less than the program-level average concentration. By comparison, NBIL's 2015 annual average concentration of *p*-dichlorobenzene is nearly three times greater than the program-level average concentration. As noted in the previous section, this annual average concentration ranks seventh highest among NMP sites sampling this pollutant. Even if the maximum concentration was excluded from the dataset, NBIL's ranking would not change.

- A box plot for ROIL is not presented in Figure 10-12 because *p*-dichlorobenzene was not identified as a pollutant of interest for this site.

Figure 10-13. Program vs. Site-Specific Average 1,2-Dichloroethane Concentrations

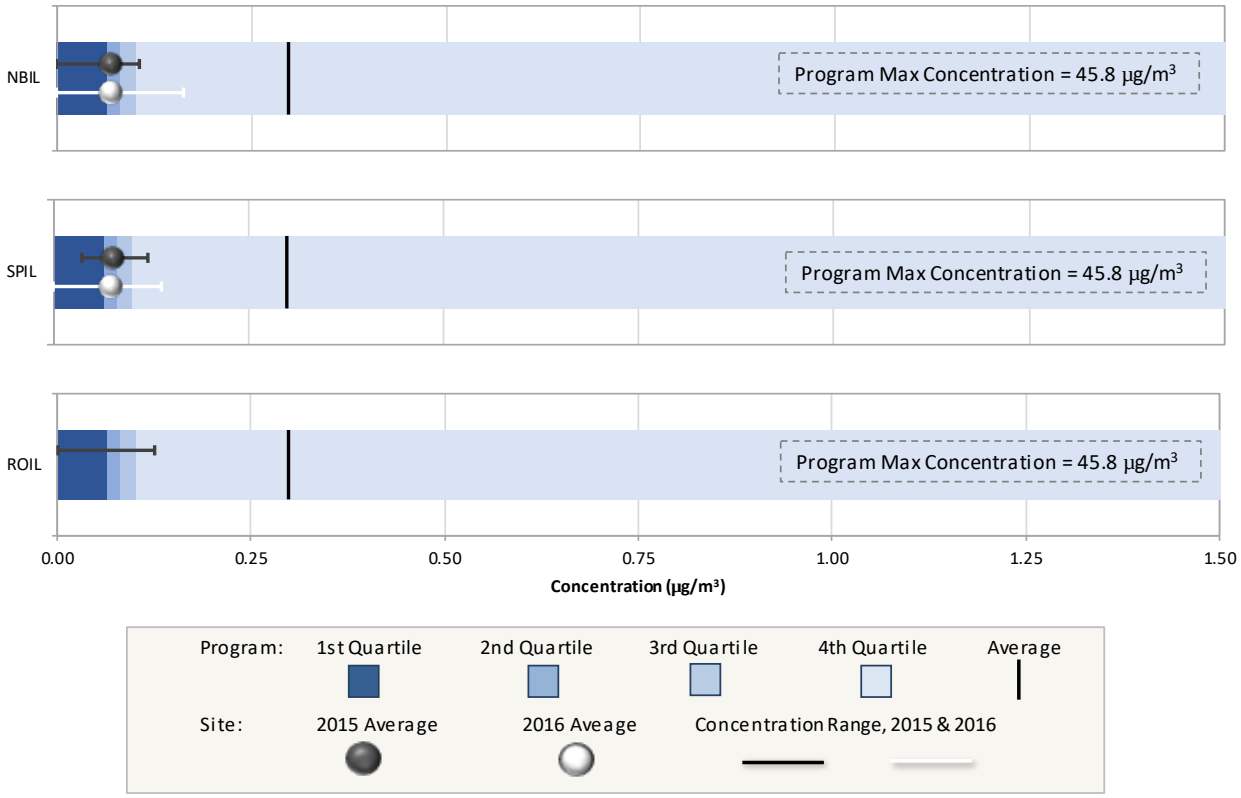


Figure 10-13 presents the box plots for 1,2-dichloroethane for all three sites and shows the following:

- The scale of the box plots for 1,2-dichloroethane has also been reduced to allow for the observation of data points at the lower end of the concentration range, as the program-level maximum 1,2-dichloroethane concentration (45.8 µg/m^3) is considerably higher than the majority of measurements. This is an example of measurements at the upper end of the concentration range driving the program-level average concentration, as the program-level average is nearly three times greater than the program-level third quartile.

- All of the 1,2-dichloroethane concentrations measured at the Illinois sites are less than the program-level average concentration of 0.30 µg/m^3. In fact, all but one measurement are less than 0.15 µg/m^3.

- Less than 0.01 µg/m^3 separates the annual average concentrations of 1,2-dichloroethane for NBIL and SPIL. Each of these fall between the program-level first quartile and median concentrations.

Figure 10-14. Program vs. Site-Specific Average Fluoranthene Concentrations

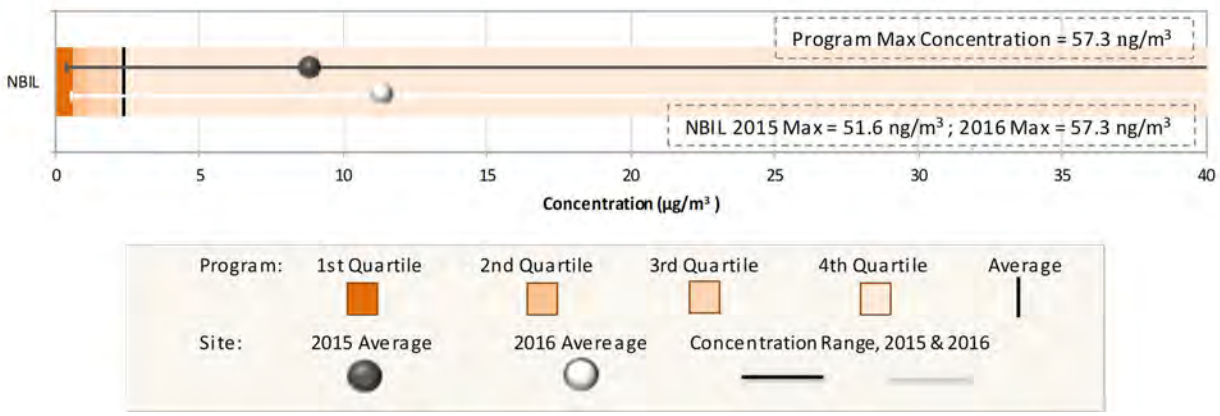


Figure 10-14 presents the box plot for fluoranthene for NBIL and shows the following:

- NBIL is the only Illinois site to sample PAHs under the NMP in 2015 and 2016. The program-level maximum concentration (57.3 ng/m^3) of fluoranthene is not shown directly on the box plot because the scale has been reduced.

- The maximum fluoranthene concentrations measured each year at NBIL exceed the scale of the box plot and thus, are provided directly on the box plot. In total, six fluoranthene concentrations measured at NBIL exceed the scale of the box plot (three each year). These are also the six highest fluoranthene concentrations measured across the program.

- NBIL's annual average concentration of fluoranthene for 2016 is greater than the annual average for 2015, although both are several times greater than the program-level average of 2.39 ng/m^3. More than half of NBIL's individual fluoranthene measurements are greater than the program-level average concentration.

Figure 10-15. Program vs. Site-Specific Average Fluorene Concentrations

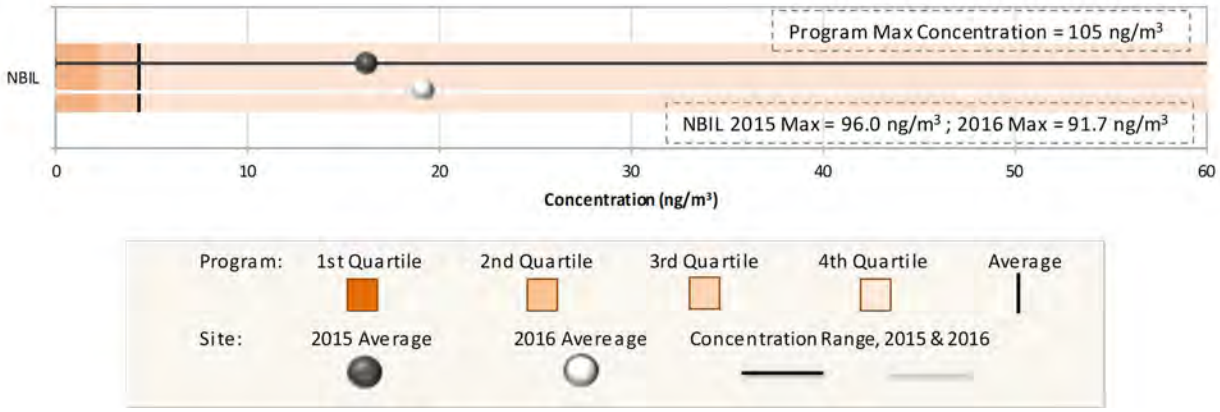


Figure 10-15 presents the box plot for fluorene for NBIL and shows the following:

- Fluorene is another PAH pollutant of interest for NBIL. Similar to the box plots for the other PAHs, the program-level maximum concentration (105 ng/m^3) of fluorene is

not shown directly on the box plot because the scale has been reduced. Note that the program-level first quartile is zero and thus, not visible on the box plot.

- The maximum fluorene concentrations measured each year at NBIL also exceed the scale of the box plot and thus, are also provided directly on the box plot. In total, nine fluorene concentrations measured at NBIL exceed the scale of the box plot. Only two NMP sites have individual fluorene concentrations greater than 45 ng/m^3, with concentrations measured at NBIL accounting for nearly all of them (15 out of 16).

- NBIL's annual average fluorene concentrations for 2015 and 2016 are nearly four and five times greater than the program-level average concentration of 4.36 ng/m^3; more than half of NBIL's fluorene measurements are greater than the program-level average concentration. A similar observation was made in the 2014 NMP report.

Figure 10-16. Program vs. Site-Specific Average Formaldehyde Concentrations

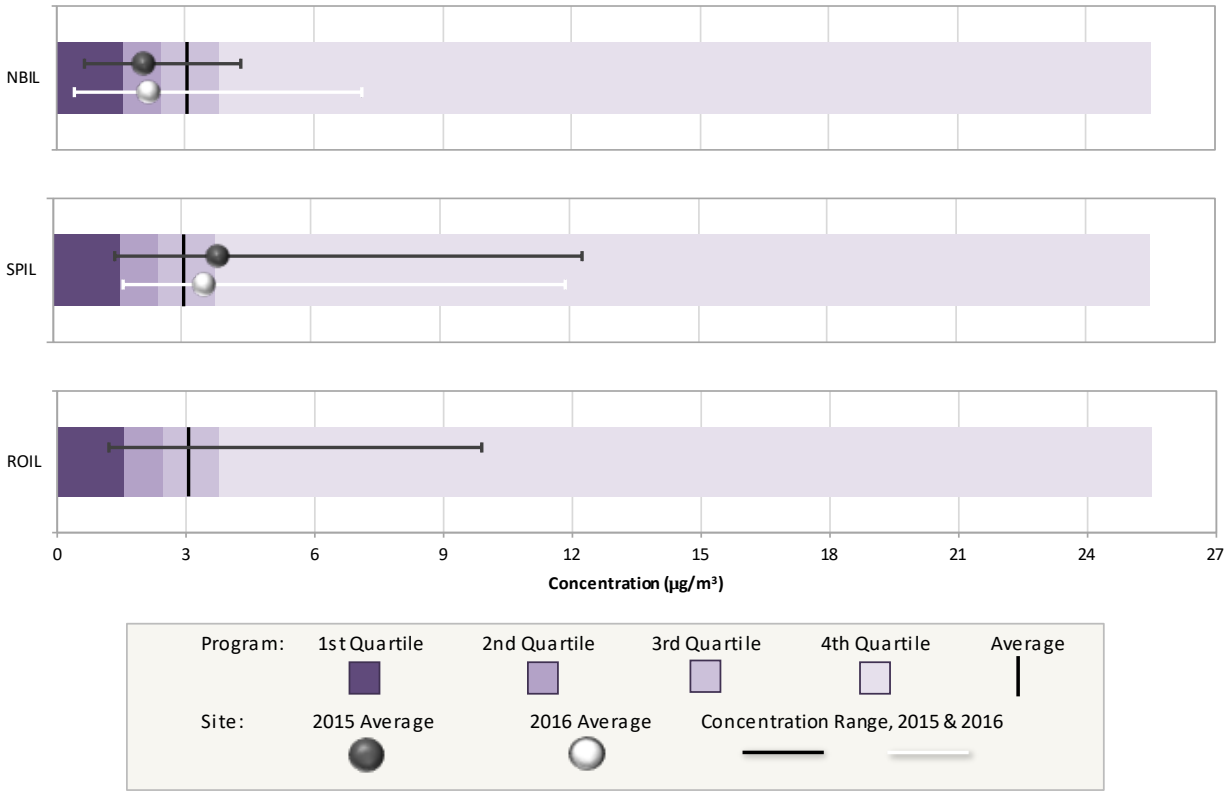


Figure 10-16 presents the box plots for formaldehyde for all three sites and shows the following:

- The range of formaldehyde concentrations measured at these sites is smallest for NBIL and largest for SPIL.

- The range of formaldehyde concentrations measured each year at SPIL are similar to each other. At NBIL, the range of concentrations measured in 2016 is larger than the range measured in 2015. Six formaldehyde concentrations measured in 2016, ranging

from 4.80 µg/m^3 to 7.11 µg/m^3, are greater than the maximum formaldehyde concentration measured in 2015 (4.30 µg/m^3).

- Both annual average concentrations of formaldehyde for NBIL are less than the program-level median concentration of 2.47 µg/m^3. Both annual average concentrations of formaldehyde for SPIL are greater than the program-level average concentration of 3.05 µg/m^3, with the annual average for 2015 also greater than the program-level third quartile.

- Only one formaldehyde concentration measured at SPIL is less than the program-level first quartile.

Figure 10-17. Program vs. Site-Specific Average Naphthalene Concentrations

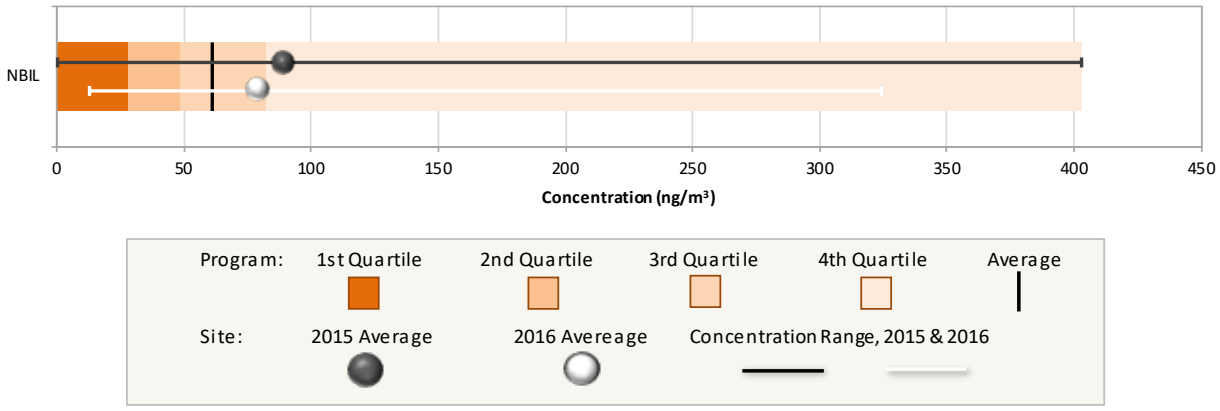


Figure 10-17 presents the box plot for naphthalene for NBIL and shows the following:

- The maximum naphthalene concentration measured at NBIL is the maximum concentration measured across the program. This was also true in 2013 and 2014. NBIL is the only NMP site at which a naphthalene concentration greater than 400 ng/m^3 was measured.

- Both the minimum and maximum concentrations of naphthalene were measured at NBIL in 2015. Note the difference between the minimum concentration measured at NBIL in 2015 (0.446 ng/m^3) and the minimum concentration measured at NBIL in 2016 (13.0 ng/m^3).

- NBIL's annual average naphthalene concentrations are both greater than the program-level average concentration of 61.23 ng/m^3 and fall one either side of the program-level third quartile.

Figure 10-18. Program vs. Site-Specific Average Trichloroethylene Concentrations

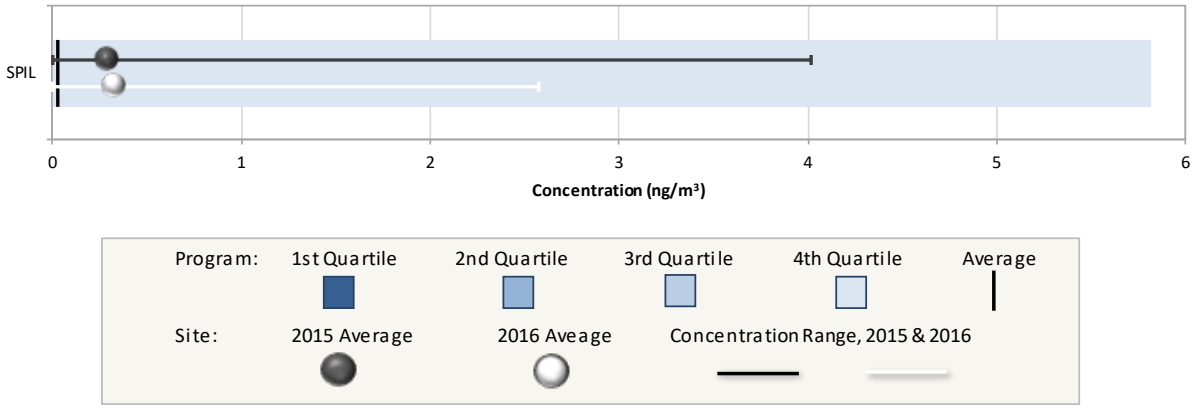


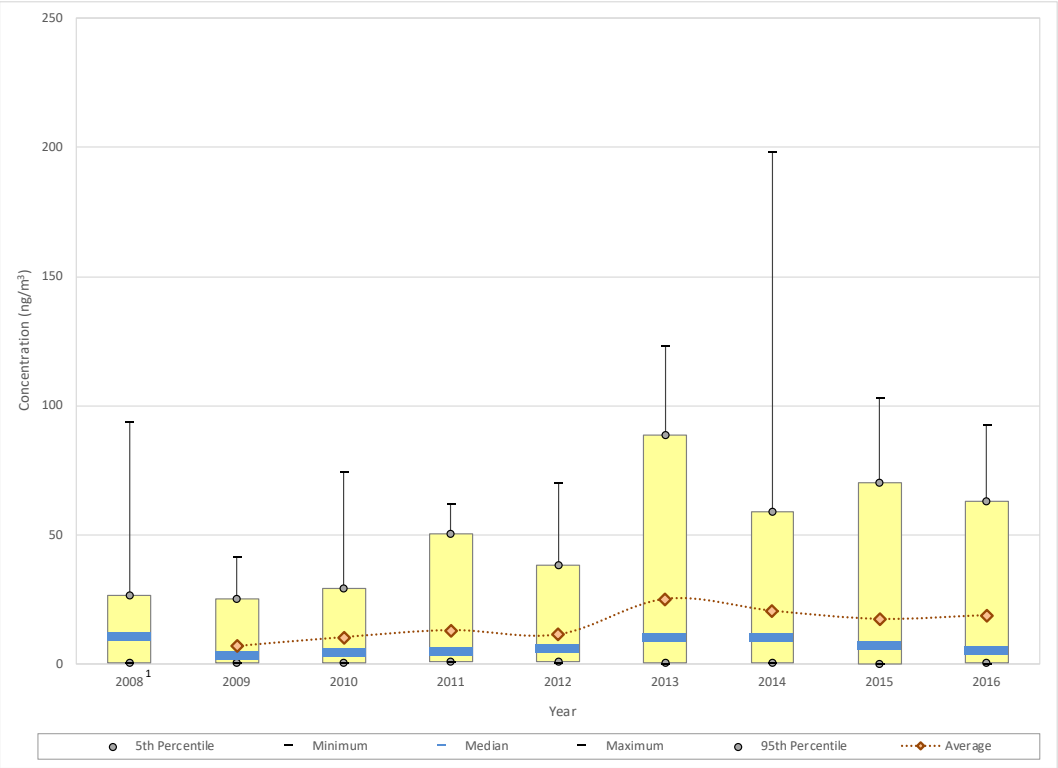
Figure 10-18 presents the box plot for trichloroethylene for SPIL and shows the following:

- SPIL is the only NMP site for which trichloroethylene is a pollutant of interest.
- The first, second, and third quartiles for trichloroethylene are zero due to the large number of non-detects; thus, only the fourth quartile is visible in Figure 10-18. The detection rate of trichloroethylene across the program in 2015 and 2016 is 21 percent.
- Although the maximum concentration of trichloroethylene across the program was measured at NBIL, the next eight highest concentrations were measured at SPIL. Among NMP sites sampling this pollutant, SPIL has the greatest number of measured detections (90), with the next closest site at CSN (54). (NBIL is fourth with 38.)
- The annual average concentrations of trichloroethylene for SPIL are an order of magnitude higher than the program-level average concentration (0.030 µg/m^3).

10.3.3 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the pollutants of interest for 5 consecutive years or longer, as described in Section 3.4.2.2. NBIL and SPIL have both sampled VOCs under the NMP since 2003. Both sites have also sampled carbonyl compounds since 2005. NBIL has also sampled PM_{10} metals since 2005 and began sampling PAHs under the NMP in 2008. Thus, Figures 10-19 through 10-38 present the 1-year statistical metrics for each of the pollutants of interest first for NBIL, then for SPIL. The statistical metrics presented for assessing trends include the substitution of zeros for non-detects. If sampling began mid-year, a minimum of 6 months of sampling is required for inclusion in the trends analysis; in these cases, a 1-year average concentration is not provided, although the range and percentiles are still presented. Because sampling at ROIL began in 2012 and ended in 2015, a trends analysis was not performed.

Figure 10-19. Yearly Statistical Metrics for Acenaphthene Concentrations Measured at NBIL



[1] A 1-year average is not presented because sampling under the NMP did not begin until June 2008.

Observations from Figure 10-19 for acenaphthene concentrations measured at NBIL include the following:

- Although PAH sampling under the NMP began at NBIL in 2008, sampling did not begin until June; because a full year's worth of data is not available for 2008, a 1-year average is not presented, although the range of measurements is provided.

- The maximum acenaphthene concentration was measured at NBIL on August 9, 2014 (198 ng/m^3), with three additional acenaphthene concentrations greater than 100 ng/m^3 measured at NBIL (two in 2013 and one in 2015). All but one of the 11 acenaphthene concentrations greater than 75 ng/m^3 were measured at NBIL in 2013 or later.

- The median concentration decreased significantly from 2008 to 2009. This is because there are a greater number of concentrations at the lower end of the concentration range in 2009. The number of acenaphthene concentrations less than 2 ng/m^3 increased from seven in 2008 to 24 in 2009. As previously noted, 2008 does not include a full year's worth of sampling. The median concentration increases steadily between 2009 and 2012, after which the median doubles for 2013, and changes little for 2014.

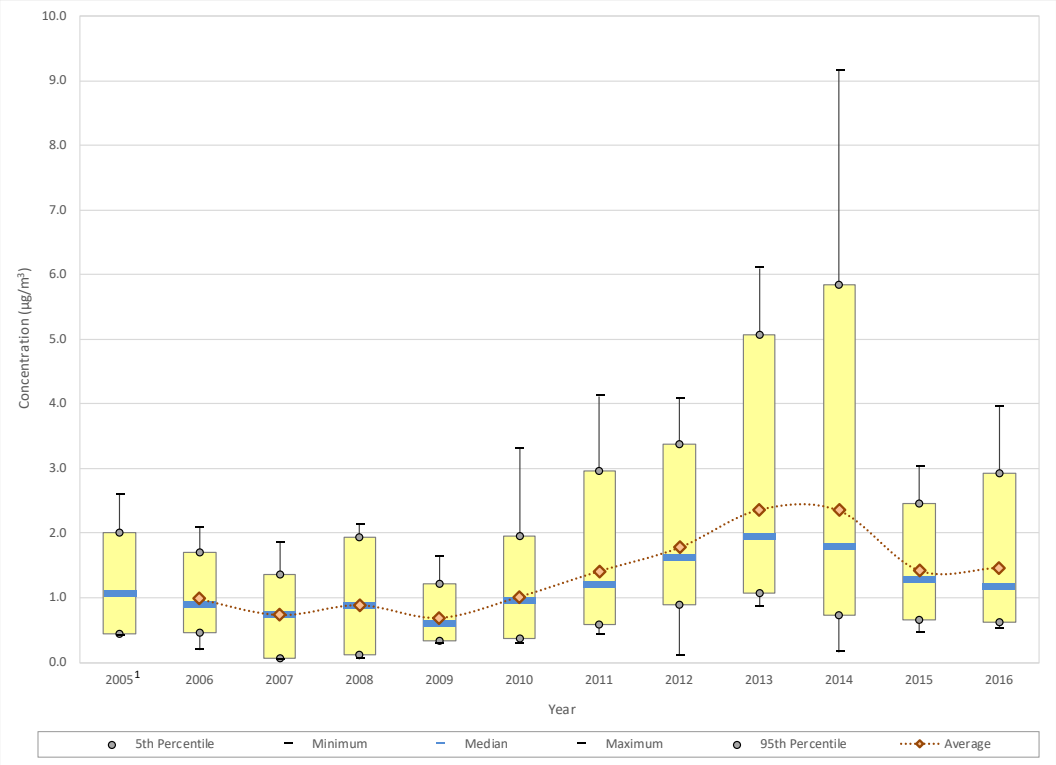
- The 1-year average concentration increases between 2009 and 2011, nearly doubling over this time frame. However, confidence intervals calculated for these averages

indicate that the increase is not statistically significant due to the relatively large amount of variability in the measurements. The 1-year average decreased slightly for 2012, although the median continued to increase. For 2013, the 1-year average concentration more than doubled, with similar increases for the median, 95th percentile, and maximum concentration. Five acenaphthene concentrations measured in 2013 are greater than the maximum concentrations measured in 2012. Additionally, the number of acenaphthene concentrations greater than 50 ng/m^3 measured at NBIL increased from one in 2012 to 11 in 2013, with no more than four measured in any of the previous years.

- Even though the maximum concentration measured approached 200 ng/m^3 in 2014, the 95th percentile decreased considerably and the 1-year average exhibits a decrease as well (while the median changed little). The number of acenaphthene concentrations greater than 75 ng/m^3 measured at NBIL decreased from five in 2013 to one in 2014. Between 2013 and 2016, the median concentration decreases by half. A slight decrease is also shown in the 1-year average concentration for 2015, followed by a slight increase for 2016.

- Although difficult to discern, the only non-detects of acenaphthene measured at NBIL were measured in 2015 (5) and 2016 (1).

Figure 10-20. Yearly Statistical Metrics for Acetaldehyde Concentrations Measured at NBIL



[1] A 1-year average is not presented because sampling under the NMP did not begin until March 2005.

Observations from Figure 10-20 for acetaldehyde concentrations measured at NBIL include the following:

- Carbonyl compound sampling at NBIL under the NMP began in March 2005; because a full year's worth of data is not available for 2005, a 1-year average concentration is not presented, although the range of measurements is provided.

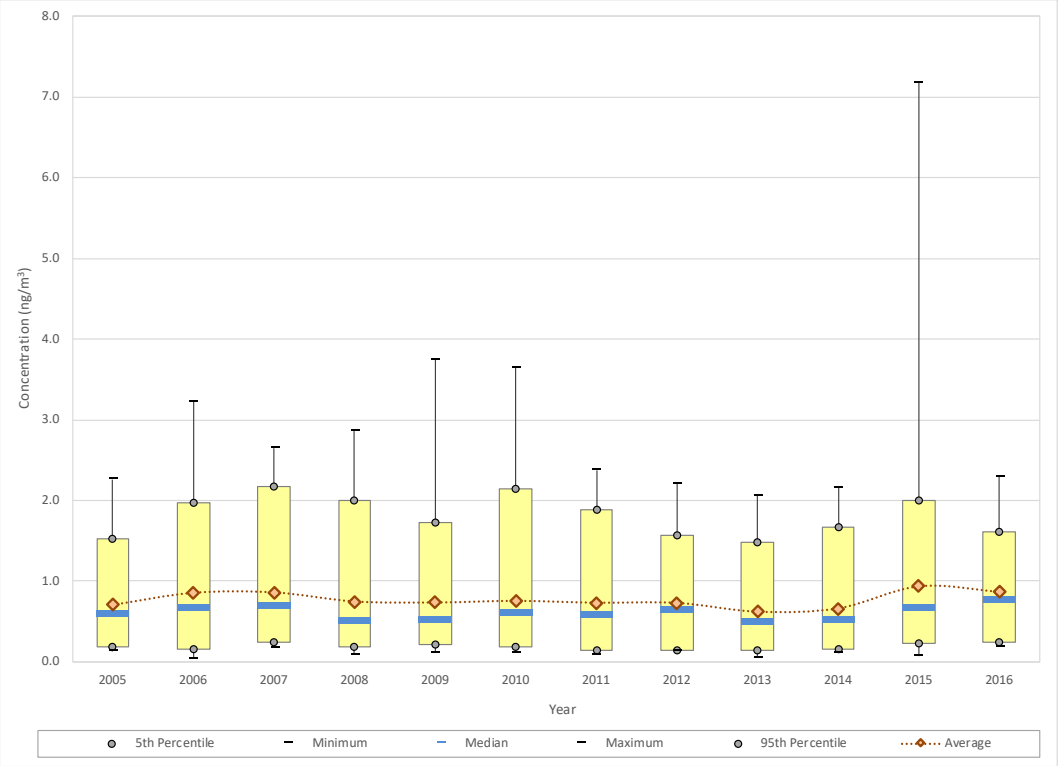
- The maximum acetaldehyde concentration measured at NBIL (9.17 $\mu g/m^3$) was measured in 2014, along with four of the five highest concentrations since the onset of sampling. The 14 highest acetaldehyde concentrations were measured in 2013 and 2014 and all 44 acetaldehyde concentrations greater than 3 $\mu g/m^3$ measured at NBIL were measured after 2009 (with the majority, 15 each, measured in 2013 and 2014).

- Prior to 2010, the 1-year average concentrations were all less than 1 $\mu g/m^3$, fluctuating between 0.69 $\mu g/m^3$ (2009) and 0.98 $\mu g/m^3$ (2006). Acetaldehyde concentrations measured at NBIL increased significantly after 2009. The steady increasing trend continues through 2013. The increase in the 1-year average concentration of acetaldehyde between 2009 and 2013 represents a 243 percent increase.

- The range of acetaldehyde concentrations measured at NBIL expanded in 2014. Two acetaldehyde concentrations greater than the maximum concentration for 2013 were measured in 2014 while seven concentrations less than the minimum concentration for 2013 were measured in 2014. Yet, little difference is shown in the 1-year average concentration between these two years. The median concentration decreased slightly for 2014, but is still greater than the 1-year average and median concentrations shown for all years prior to 2013.

- A significant decrease in the acetaldehyde concentrations measured at NBIL is shown for 2015, with the smallest range of concentrations measured since 2009, and a 40 percent decrease in the 1-year average concentration. While the range of measurements increased somewhat for 2016, little change is shown in the 1-year average concentration, and the median exhibits a slight decrease.

Figure 10-21. Yearly Statistical Metrics for Arsenic (PM_{10}) Concentrations Measured at NBIL



Observations from Figure 10-21 for arsenic (PM_{10}) concentrations measured at NBIL include the following:

- Metals sampling under the NMP began at NBIL in January 2005.

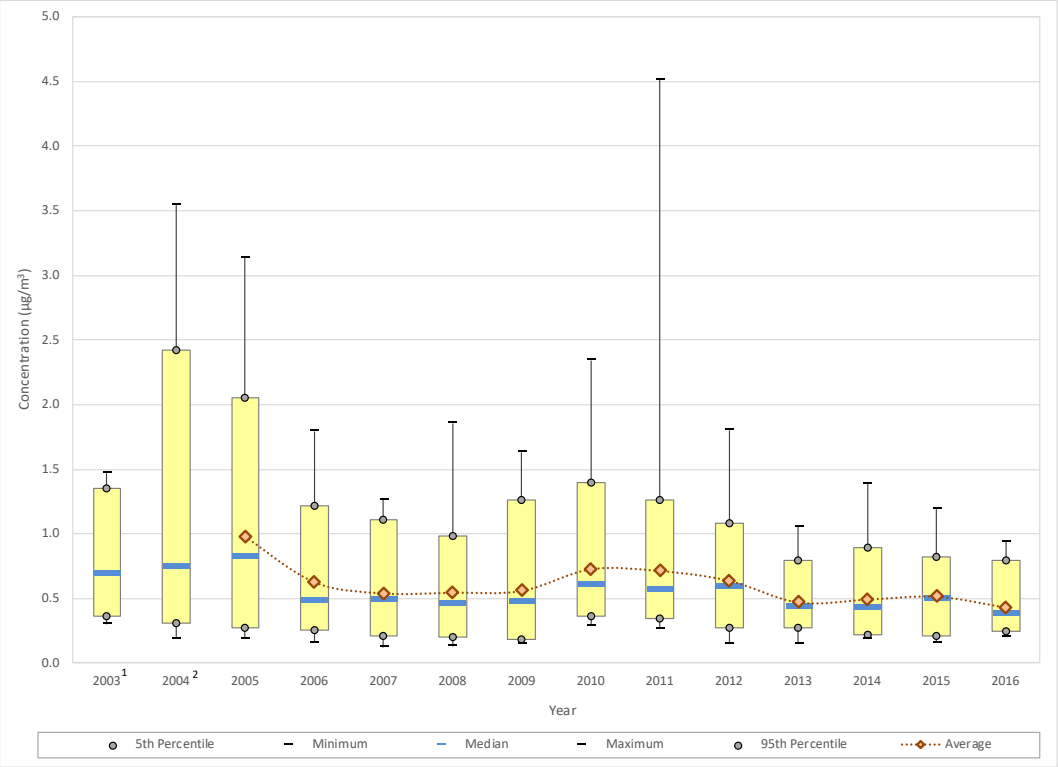
- The maximum arsenic concentration was measured at NBIL on July 5, 2015 (7.18 ng/m^3). Additional arsenic concentrations greater than 4 ng/m^3 have not been measured at this site. Excluding the maximum, five arsenic concentrations greater than 3 ng/m^3 have been measured at NBIL (one each in 2006, 2009, and 2015, and two in 2010).

- Although the statistical parameters representing the upper end of the concentration range have fluctuated somewhat each year, the 1-year average concentrations exhibit relatively little significant change over most of the years sampling. Between 2005 and 2014, less than 0.25 ng/m^3 separates the 1-year average concentrations, including a 5-year period where the 1-year average concentration hovered around 0.75 ng/m^3.

- Most of the statistical parameters are at a minimum for 2013, with the 1-year average concentration (0.62 ng/m^3) at its lowest since the onset of sampling. Little change is shown for 2014, after which most of the statistical parameters exhibit increases for 2015. This would be true even if the maximum concentration was excluded from the dataset. The 1-year average concentration is at a maximum for 2015 (0.94 ng/m^3).

- While the maximum, 95th percentile, and 1-year average concentration exhibit decrease for 2016, the minimum, 5th percentile, and median concentrations exhibit increases. In fact, these latter three statistical parameters are at their highest since the onset of sampling.

Figure 10-22. Yearly Statistical Metrics for Benzene Concentrations Measured at NBIL



[1] A 1-year average is not presented because sampling under the NMP did not begin until April 2003.
[2] A 1-year average is not presented because there was a gap in sampling from late October 2004 through the end of the year.

Observations from Figure 10-22 for benzene concentrations measured at NBIL include the following:

- Although sampling for VOCs at NBIL under the NMP began in 2003, sampling did not begin until April; because a full year's worth of data is not available, a 1-year average is not presented, although the range of measurements is provided. In addition, sampling for VOCs was discontinued in October 2004 through the end of the year. Thus, a 1-year average is not presented for 2004 either.

- The maximum benzene concentration (4.51 µg/m^3) was measured on January 9, 2011 and is the only benzene measurement greater than 4 µg/m^3 measured at NBIL. Three additional benzene concentrations greater than 3 µg/m^3 were measured in 2004 and 2005 and most of the measurements greater than 2 µg/m^3 were measured in 2004.

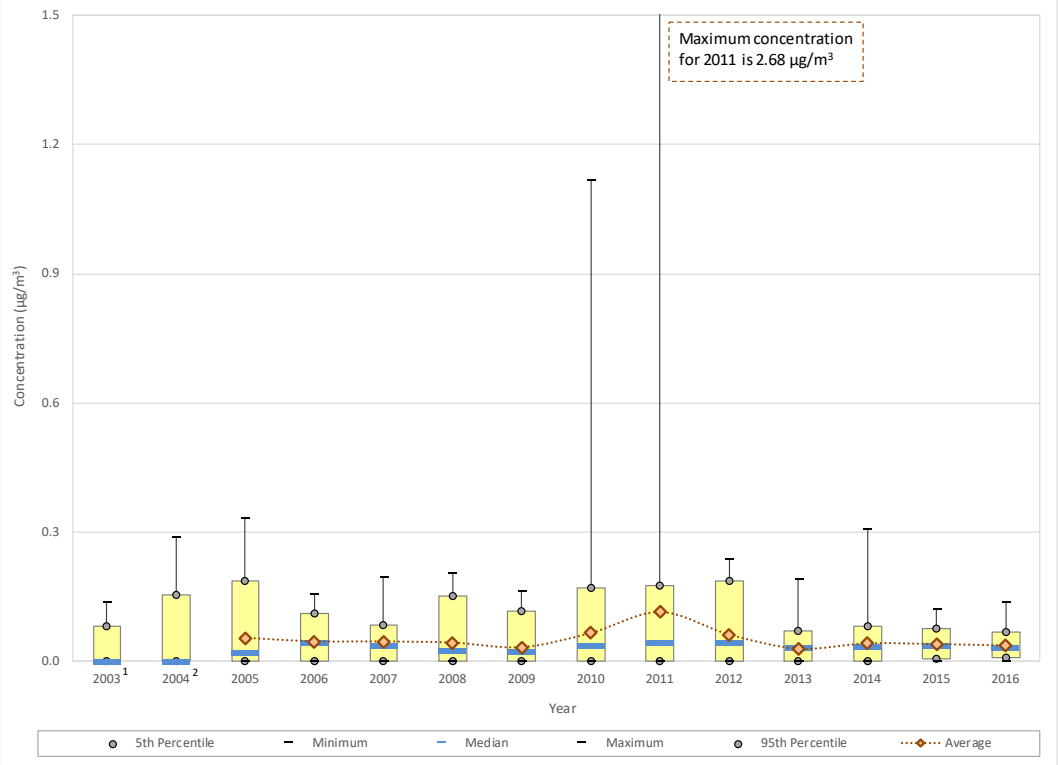
- A decreasing trend in the concentrations of benzene is shown through 2007. The 1-year average concentration decreased significantly from 2005 to 2006, with an additional slight decrease for 2007. Between 2005 and 2007, the 1-year average

concentration decreased by almost half, after which the 1-year average remained steady through 2009.

- All of the statistical parameters exhibit increases from 2009 to 2010. Although the maximum concentration nearly doubled from 2010 to 2011, the rest of the statistical parameters decreased for 2011 (albeit slightly). This decreasing continued into 2012 (although the median concentration actually increased slightly) and 2013, which is the first year the 1-year average concentration is less than 0.5 µg/m^3.

- Benzene concentrations greater than 1.5 µg/m^3 were not measured at NBIL during the 4-year period between 2013 and 2016 and benzene concentrations greater than 1 µg/m^3 were not measured in 2016. The entire range of concentrations spans less than 0.75 µg/m^3 in 2016, when the 1-year average concentration is at a minimum (0.43 µg/m^3).

Figure 10-23. Yearly Statistical Metrics for 1,3-Butadiene Concentrations Measured at NBIL



[1] A 1-year average is not presented because sampling under the NMP did not begin until April 2003.
[2] A 1-year average is not presented because there was a gap in sampling from late October 2004 through the end of the year.

Observations from Figure 10-23 for 1,3-butadiene concentrations measured at NBIL include the following:

- The maximum 1,3-butadiene concentration was measured at NBIL on the same day as the maximum benzene concentration, January 9, 2011 (2.68 µg/m^3). Only three 1,3-butadiene concentrations greater than 1 µg/m^3 have been measured at NBIL (two

in 2011 and one in 2010). All other concentrations of 1,3-butadiene measured at NBIL are less than 0.35 µg/m^3.

- For each year shown through 2014, the minimum and 5th percentile are zero, indicating the presence of non-detects. For the first 2 years of sampling, the median concentration is also zero, indicating that at least half of the measurements were non-detects. The percentage of non-detects reported has fluctuated over the years of sampling, from as high as 88 percent (2004) to as low as 5 percent (2016).

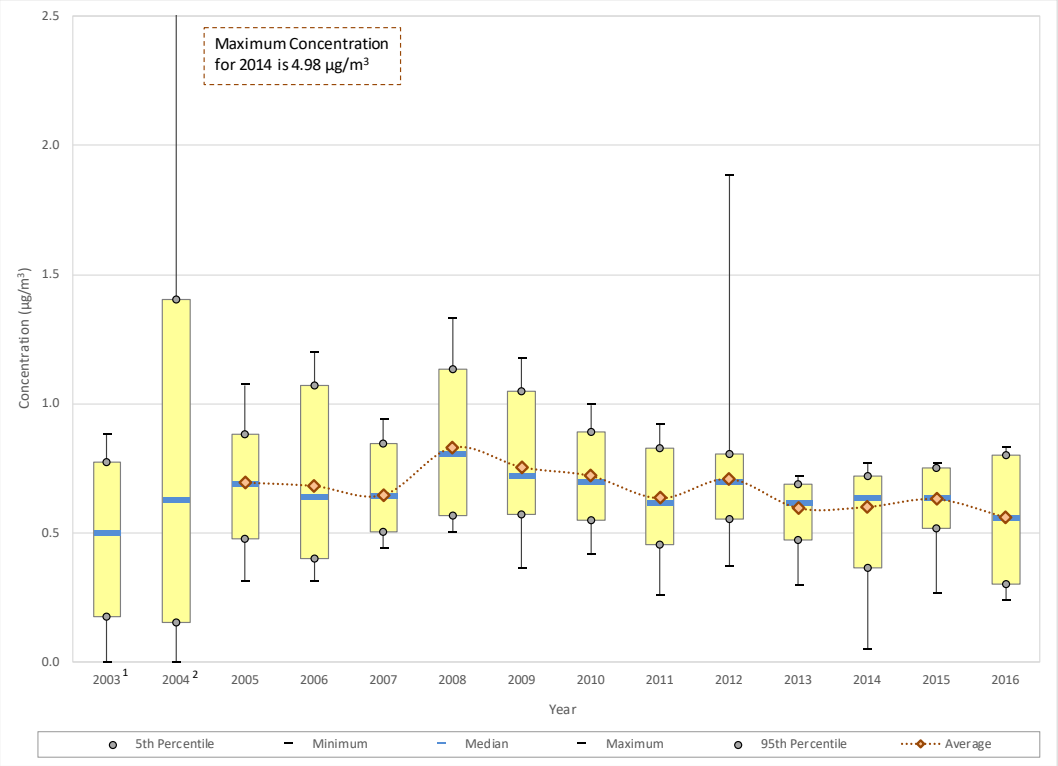
- The 1-year average concentration decreased slightly between 2005 and 2009, although the changes are not statistically significant. From 2009 to 2010, the 1-year average doubled, and then nearly doubled again for 2011. There is, however, a significant amount of variability associated with these measurements, based on the confidence intervals associated with these averages. Even with the relatively high concentrations measured in 2010 and 2011, the 95th percentile changed only slightly, indicating that the majority of concentrations measured were within a similar range. If the three outlier concentrations measured in 2010 and 2011 were excluded from the calculations, the 1-year average concentrations for these years would still be greater than the 1-year average for 2009, but they would be similar to the averages shown for years prior.

- Excluding the two years with outliers, the 1-year average and median concentrations are highest for 2012. Although the range of concentrations measured is similar to other years, 2012 has the highest number of 1,3-butadiene concentrations (13) greater than 0.1 µg/m^3 than any other year of sampling.

- The range within which the majority of concentrations fall, as determined by the 5th and 95th percentiles, decreased considerably from 2012 to 2013, and remained fairly steady through 2016.

- The 1-year average concentration decreased significantly from 2012 to 2013, and varies by about 0.01 µg/m^3 in the years that follow.

Figure 10-24. Yearly Statistical Metrics for Carbon Tetrachloride Concentrations Measured at NBIL



[1] A 1-year average is not presented because sampling under the NMP did not begin until April 2003.
[2] A 1-year average is not presented because there was a gap in sampling from late October 2004 through the end of the year.

Observations from Figure 10-24 for carbon tetrachloride concentrations measured at NBIL include the following:

- The maximum concentration of carbon tetrachloride was measured in 2004 (4.98 µg/m^3). Only one additional measurement greater than 1.5 µg/m^3 has been measured at NBIL (1.88 µg/m^3 in 2012).

- Five non-detects of carbon tetrachloride have been measured at NBIL. All of these were measured during the first 2 years of sampling (two in 2003 and three in 2004).

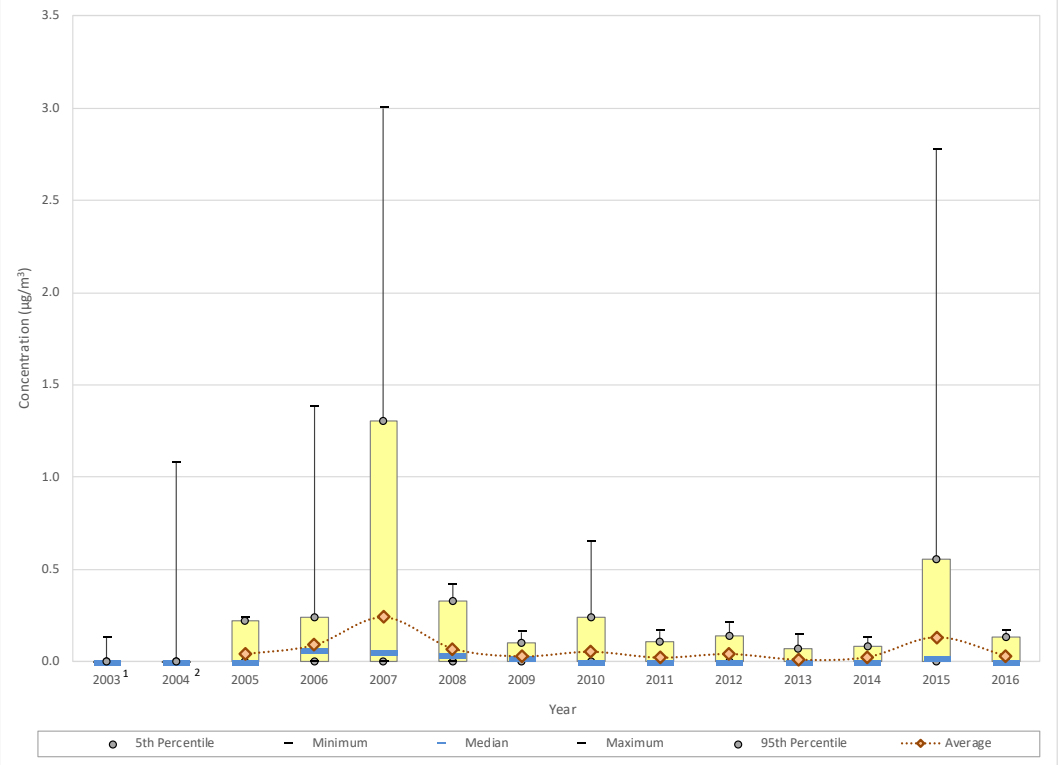
- The statistical parameters for 2003 and 2004 have a different appearance than the parameters shown for the years afterward, particularly for 2004, when the range of measurements is at its largest and several non-detects were measured. However, neither year represents a full year of sampling.

- After decreasing slightly between 2005 and 2007, the 1-year average concentration increased significantly for 2008. This increase is followed by a significant decreasing trend that continued through 2011, when the 1-year average returned to 2007 levels. After exhibiting an increase for 2012, the 1-year average concentration decreased again for 2013 and is less than 0.60 µg/m^3 for the first time. The slight increases shown for 2014 and 2015 are followed by a decrease for 2016, when the 1-year

average concentration is at a minimum (0.56 µg/m^3). However, less than 0.07 µg/m^3 separates the 1-year averages calculated between 2013 and 2016.

- The median carbon tetrachloride concentration has a similar pattern as the 1-year average concentration and is also at a minimum for 2016 (0.56 µg/m^3).

Figure 10-25. Yearly Statistical Metrics for *p*-Dichlorobenzene Concentrations Measured at NBIL



[1] A 1-year average is not presented because sampling under the NMP did not begin until April 2003.
[2] A 1-year average is not presented because there was a gap in sampling from late October 2004 through the end of the year.

Observations from Figure 10-25 for *p*-dichlorobenzene concentrations measured at NBIL include the following:

- The maximum concentration of *p*-dichlorobenzene was measured in 2007 (3.00 µg/m^3), although a concentration of similar magnitude was also measured in 2015 (2.78 µg/m^3). In total, eight for *p*-dichlorobenzene concentrations greater than 1 µg/m^3 have been measured at NBIL, the majority of which were measured in 2007 (five).

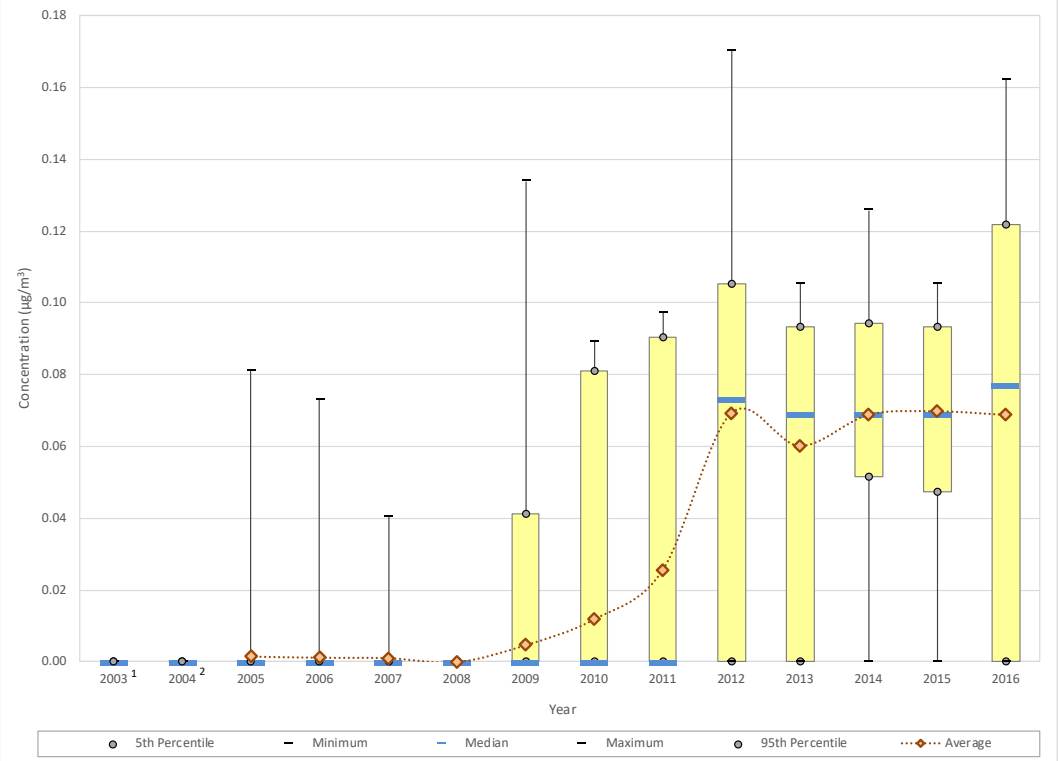
- For each year shown, the minimum and 5th percentile are zero, indicating the presence of non-detects. The median concentration is also zero for several years, indicating that at least half of the measurements were non-detects. The percentage of non-detects reported has varied over the years of sampling, from 28 percent (2007) to 97 percent (2003).

- In 2003 and 2004, non-detects account for nearly all of the measurements (only one and two measured detections, respectively). The percentage of non-detects decreased considerably each year through 2007, when the number of non-detects is at a minimum and the magnitude of the measured detections is at a maximum. The 1-year average concentration of *p*-dichlorobenzene increased six-fold between 2005 and 2007. The 1-year average concentration for 2007 is greater than the 95th percentile for most other years of sampling.

- A significant decrease in concentrations of *p*-dichlorobenzene is shown after 2007 and through 2009, when the range of measurements is at its smallest since the first year of sampling. Between 2010 and 2014, the 1-year average concentration has a undulating pattern, where a slightly higher 1-year average is followed by a slightly lower 1-year average. The median concentration returned to zero during this 5-year period, indicating that at least half of the measurements are non-detects.

- An increase is shown for nearly all of the statistical parameters for 2015, when four concentrations greater than 0.5 µg/m^3 were measured, the first year since 2010 and the most since 2007. This increase is followed by a return to levels shown prior to 2015.

Figure 10-26. Yearly Statistical Metrics for 1,2-Dichloroethane Concentrations Measured at NBIL



[1] A 1-year average is not presented because sampling under the NMP did not begin until April 2003.
[2] A 1-year average is not presented because there was a gap in sampling from late October 2004 through the end of the year.

Observations from Figure 10-26 for 1,2-dichloroethane concentrations measured at NBIL include the following:

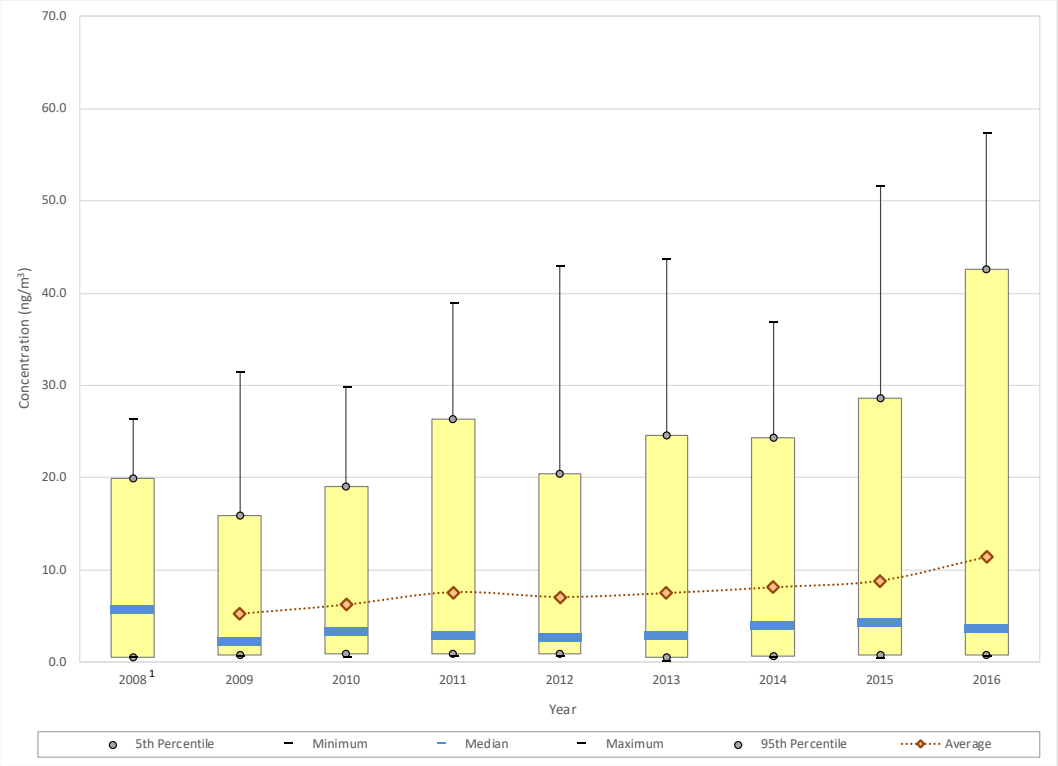
- There were no measured detections of 1,2-dichloroethane in 2003, 2004, or 2008. The percentage of non-detects between 2005 and 2007 was greater than 95 percent. Thus, the minimum, 5th percentile, median, and in some cases the 1-year average concentrations, were zero between 2003 and 2008. The median concentration remained zero through 2011, indicating that at least half of the measurements are non-detects.

- The number of non-detects began to decrease starting with 2009 and continued through 2012. The median concentration is greater than zero for the first time for 2012 and is also greater than the 1-year average concentration. This is because the eight non-detects (or zeros) factored into the 1-year average concentration are pulling the average down (in the same manner that a maximum or outlier concentration can drive the average up) but are not contributing to the majority of measurements for the first time. This is also true for 2013, although the number of non-detects increased slightly (from 8 to 10).

- The 5th percentile is greater than zero for the first time for 2014, when only two non-detects of 1,2-dichloroethane were measured at NBIL. This is also true for 2015, when a single non-detect was measured. The 5th percentile returned to zero for 2016, when the number of non-detects increased considerably (nine).

- Between 2012 and 2016, the 1-year average concentrations ranged from 0.06 µg/m^3 (2013) to 0.07 µg/m^3 (2015), varying by only 0.01 µg/m^3. If 2013 is excluded, the range varies by less than 0.001 µg/m^3. The decrease in the 1-year average for 2013 does not result solely based on the two additional non-detects measured, though they are a factor. The 95th percentile for 2012 is the same as the maximum concentration measured in 2013; seven concentrations greater than 0.1 µg/m^3 were measured in 2012 compared to only two in 2013. While this is also true for 2014, the low number of 1,2-dichloroethane concentrations greater than 0.1 µg/m^3 measured in 2014 is counterbalanced by the reduced number of non-detects, resulting in a 1-year average concentration more similar to the one calculated for 2012.

Figure 10-27. Yearly Statistical Metrics for Fluoranthene Concentrations Measured at NBIL



[1] A 1-year average is not presented because sampling under the NMP did not begin until June 2008.

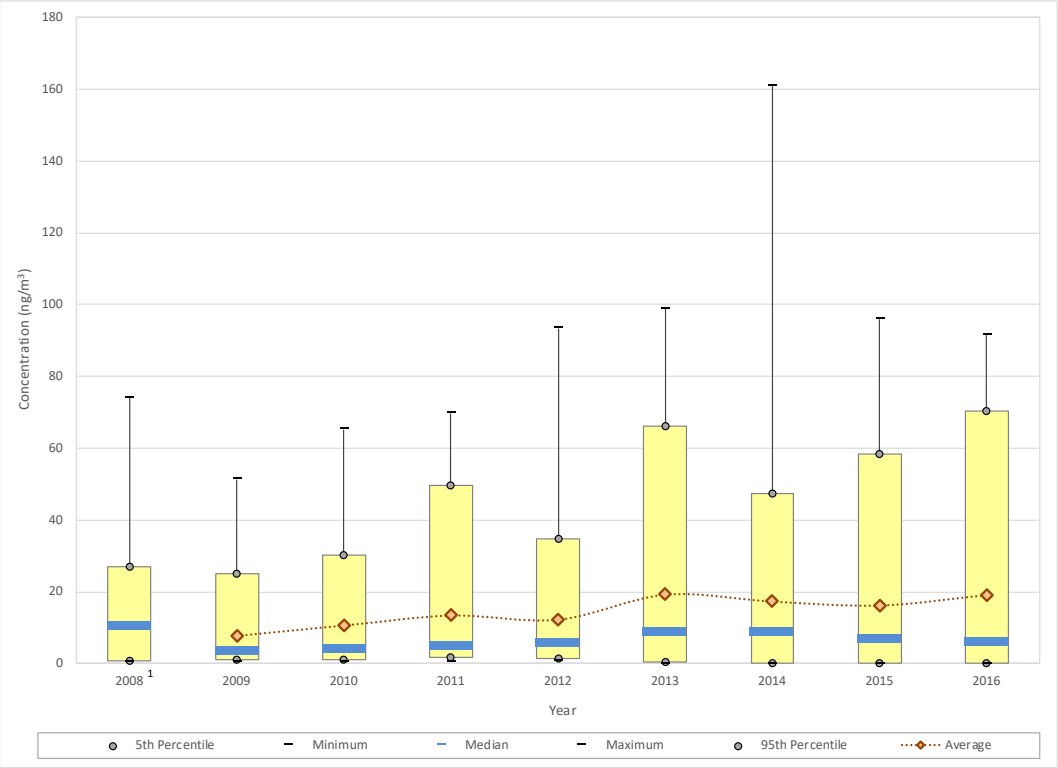
Observations from Figure 10-27 for fluoranthene concentrations measured at NBIL include the following:

- Four fluoranthene concentrations greater than 50 ng/m^3 have been measured at NBIL, three in 2016 and one in 2015.

- The median concentration decreased by more than half from 2008 to 2009. This is because there is a greater number of fluoranthene concentrations at the lower end of the concentration range for 2009. The number of measurements less than 2 ng/m^3 tripled from 2008 to 2009, increasing from nine in 2008 to 27 in 2009. Note, however, that 2008 does not include a full year's worth of sampling. The median fluoranthene concentrations shown between 2009 and 2014 vary by less than 2 ng/m^3.

- An overall increasing trend is shown in the concentrations of fluoranthene measured at NBIL. The 1-year average concentration has doubled since the first full year of sampling. Confidence intervals calculated for these averages, though, indicate a relatively large amount of variability in the measurements.

Figure 10-28. Yearly Statistical Metrics for Fluorene Concentrations Measured at NBIL



[1] A 1-year average is not presented because sampling under the NMP did not begin until June 2008.

Observations from Figure 10-28 for fluorene concentrations measured at NBIL include the following:

- The statistical patterns for fluorene resemble the statistical patterns shown on the trends graph for acenaphthene and, to a lesser extent, fluoranthene.

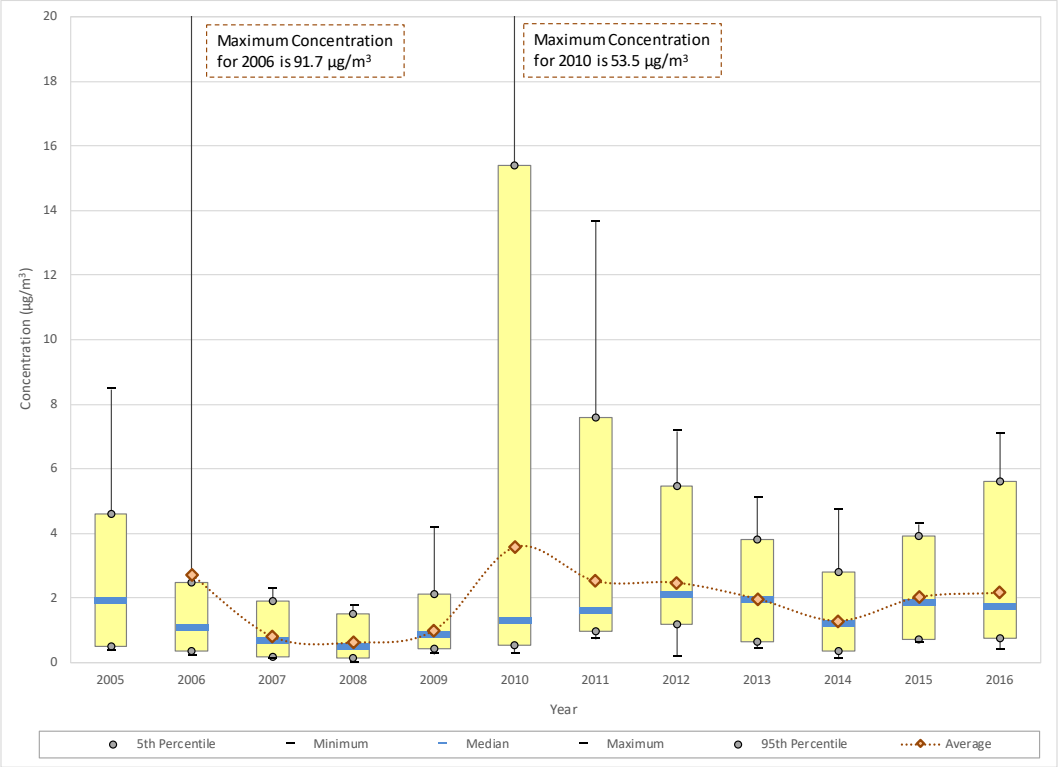
- The maximum fluorene concentration was measured at NBIL in 2014 (161 ng/m^3), and is the only concentration greater than 100 ng/m^3 measured since the onset of sampling (although one greater than 90 ng/m^3 has been measured each year since 2012).

- The median concentration of fluorene also decreased significantly from 2008 to 2009 due to the number of fluorene concentrations at the lower end of the concentration range for 2009. The number of measurements less than 3 ng/m^3 increased three-fold from 2008 to 2009, increasing from eight in 2008 to 29 in 2009. Note, however, that 2008 does not include a full year's worth of sampling.

- Like acenaphthene, the 1-year average concentration of fluorene increases between 2009 and 2011, then decreases slightly for 2012. The 1-year average concentration then increases considerably for 2013, after which the 1-year average concentration lies between 15 ng/m^3 and 20 ng/m^3 for each year. Confidence intervals calculated for these averages indicate that there is a relatively large amount of variability in these measurements.

- Non-detects of fluorene were not measured at NBIL until 2013. Both the minimum concentration and the 5th percentile are zero for 2014, 2015, and 2016, with between five (2016) and seven (2015) non-detects measured each year during this period.

Figure 10-29. Yearly Statistical Metrics for Formaldehyde Concentrations Measured at NBIL



[1] A 1-year average is not presented because sampling under the NMP did not begin until March 2005.

Observations from Figure 10-29 for formaldehyde concentrations measured at NBIL include the following:

- The maximum formaldehyde concentration was measured on January 5, 2006 (91.7 µg/m^3). The next five highest concentrations, ranging from 14.4 µg/m^3 to 53.5 µg/m^3, were all measured in 2010. The only other formaldehyde concentration greater than 10 µg/m^3 was measured in 2011 (13.7 µg/m^3).

- The maximum concentration measured in 2006 is 20 times higher than the next highest concentration measured that year (4.46 µg/m^3). The magnitude of this outlier explains why the 1-year average concentration for 2006 is greater than the 95th percentile.

- The range of formaldehyde concentrations measured in 2007, 2008, and 2009, and thus, the statistical parameters characterizing them, is considerably less than the previous two years.

- The statistical metrics for 2010 are also affected by higher concentrations; however, concentrations measured this year are higher overall, as indicated by seven-fold

increase in the 95th percentile. The 1-year average concentration more than tripled from 2009 to 2010 and the median increased by 50 percent. The concentrations measured in 2011 were less than those measured in 2010, although still higher than most years.

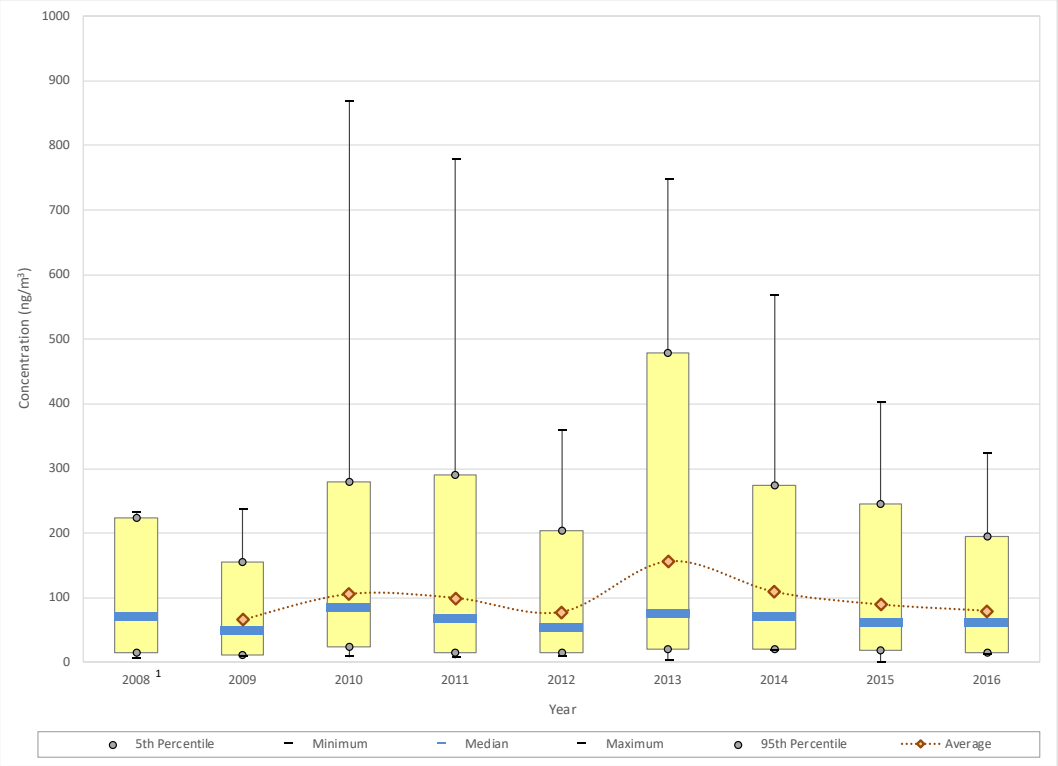
- Although the maximum formaldehyde concentration measured in 2012 is less than the 95th percentile for 2011, the 1-year average concentration changed little and the median concentration increased. This is because the number of concentrations between 2 $\mu g/m^3$ and 4 $\mu g/m^3$ nearly doubled from 2011 (15) to 2012 (29).

- The range of concentrations measured at NBIL after 2010 has a decreasing trend through 2014. The 1-year average concentration exhibits a 64 percent decrease between 2010 and 2014, although those prior to 2010 are still lower.

- Despite a smaller range of concentrations measured, the 1-year average concentration increased significantly for 2015. Concentrations measured in 2015 were generally higher than those measured in 2014. The number of formaldehyde concentrations greater than 2 $\mu g/m^3$ increased three-fold, from eight in 2014 to 25 in 2015. Additionally, the number of concentrations less than 1 $\mu g/m^3$ decreased from 21 in 2014 to seven in 2015; further, 11 concentrations measured in 2014 are less than the minimum concentration measured in 2015.

- The concentration profile for 2016 indicates that a few higher concentrations were measured; six concentrations measured at NBIL in 2016 are greater than the maximum concentration measured in 2015. Only slight changes in the central tendency statistics are shown for 2016.

Figure 10-30. Yearly Statistical Metrics for Naphthalene Concentrations Measured at NBIL



[1] A 1-year average is not presented because sampling under the NMP did not begin until June 2008.

Observations from Figure 10-30 for naphthalene concentrations measured at NBIL include the following:

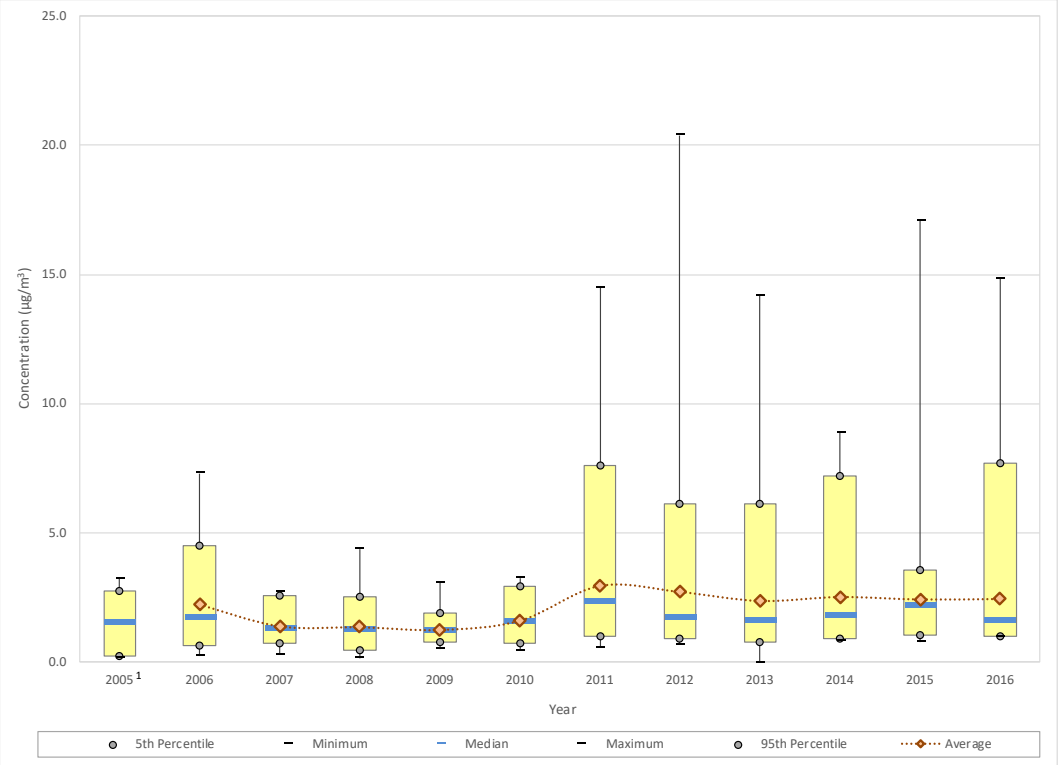
- The maximum naphthalene concentration was measured on September 23, 2010 (869 ng/m^3). Five additional naphthalene concentrations greater than 500 ng/m^3 have been measured at NBIL (one in 2011, three in 2013, and one in 2014).

- The 1-year average and median concentrations increase considerably from 2009 to 2010, when the maximum naphthalene concentration was measured. While this measurement (869 ng/m^3) is more than twice the next highest concentration measured in 2010 (363 ng/m^3), the increases are not solely a result of this outlier. Four concentrations measured in 2010 are greater than the maximum concentration measured in 2009, and the number of naphthalene concentrations greater than or equal to 100 ng/m^3 increased from 14 to 22. The concentration profile for 2011 resembles the profile for 2010, with only slight decreases shown for most of the statistical parameters.

- After additional decreases for 2012, naphthalene concentrations exhibit significant increases for 2013, when the 1-year average concentration doubled, and is at a maximum for the period of sampling (155.98 ng/m^3). The highest number of naphthalene concentrations greater than 300 ng/m^3 was measured in 2013 (11), with no other year having more than three.

- After 2013, a significant decreasing trend is shown in the concentrations of naphthalene measured at NBIL.

Figure 10-31. Yearly Statistical Metrics for Acetaldehyde Concentrations Measured at SPIL



[1] A 1-year average is not presented because consistent sampling did not begin until March 2005.

Observations from Figure 10-31 for acetaldehyde concentrations measured at SPIL include the following:

- Although the first carbonyl compound sample was collected at SPIL in February 2005, consistent sampling did not begin until March 2005; because a full year's worth of data is not available for 2005, a 1-year average is not presented, although the range of measurements is provided.

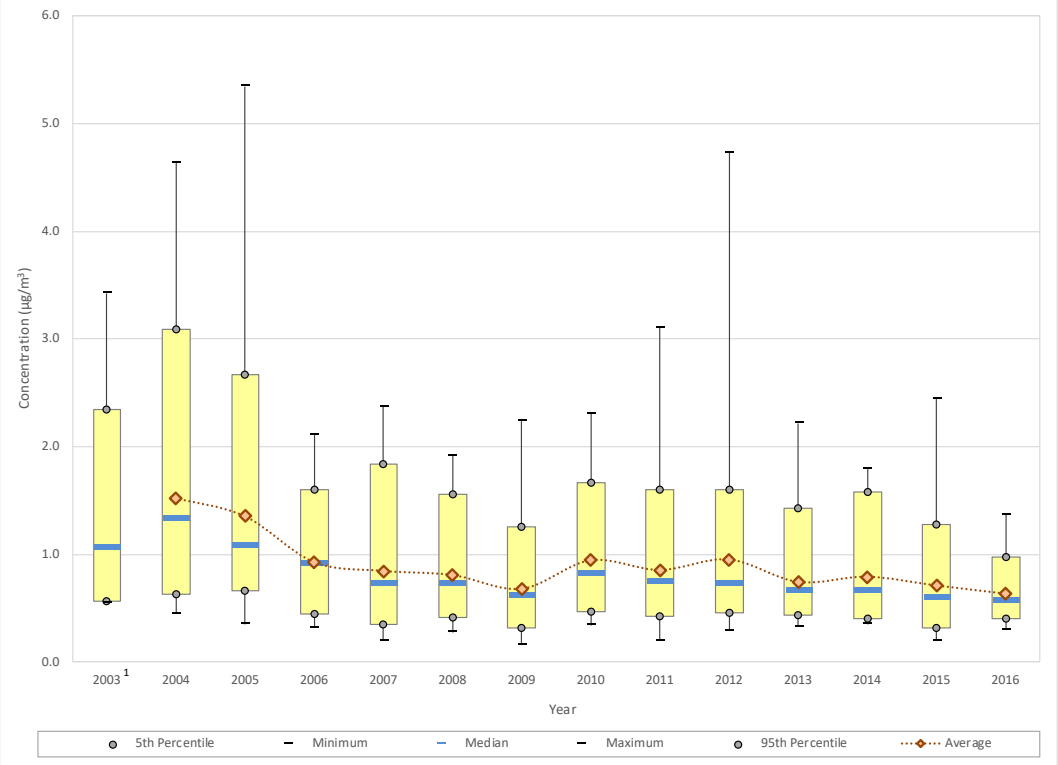
- The maximum acetaldehyde concentration was measured at SPIL on November 17, 2012 (20.4 µg/m^3). Thirty-six of the 38 concentrations of acetaldehyde greater than 5 µg/m^3 were measured after 2010 (eight each in 2011, 2012, and 2014, seven in 2013, one in 2015, and four in 2016); the other two were measured in 2006.

- The 1-year average concentration decreased significantly from 2006 to 2007, as did most of the other statistical parameters. Between 2007 and 2009, the 1-year average concentration changed little, hovering between 1.25 µg/m^3 and 1.45 µg/m^3. The 1-year average concentration increased slightly in 2010 then increased significantly in 2011. All of the statistical metrics increased for 2011, particularly the maximum and 95th percentile, indicating that the increases shown are not attributable to a few of

outliers. As an illustration, the number of measurements greater than 2 µg/m^3 increased from three in 2009 to 15 for 2010 to 40 in 2011.

- The concentration profiles for 2012 through 2016 are more similar to 2011 than other years of sampling. Yet, these measurements reflect considerable variability, based on the range of concentrations measured and spread of the central tendency statistics. Even though the 95th percentile for 2015 decreased to less than 5 µg/m^3 for the first times since 2010, the 1-year average concentration changed little and the median concentration exhibits an increase. The second highest acetaldehyde concentration was measured at SPIL in 2015 (17.1 µg/m^3) but is more than four times higher than the next highest measurement that year (3.66 µg/m^3). Even though this disparity is large, it balances out with other years where the spread of concentrations higher in magnitude is less. In addition, 2015 has the most concentrations greater than 2 µg/m^3 since 2011, which explains the increase in the median concentration. These are the only two years in which the median concentration is greater than 2 µg/m^3.

Figure 10-32. Yearly Statistical Metrics for Benzene Concentrations Measured at SPIL



[1] A 1-year average is not presented because sampling under the NMP did not begin until April 2003.

Observations from Figure 10-32 for benzene concentrations measured at SPIL include the following:

- Sampling for VOCs at SPIL under the NMP began in April 2003; because a full year's worth of data is not available for 2003, a 1-year average is not presented, although the range of measurements is provided.

- The only two concentrations of benzene greater than 5 µg/m^3 were measured at SPIL in 2005.

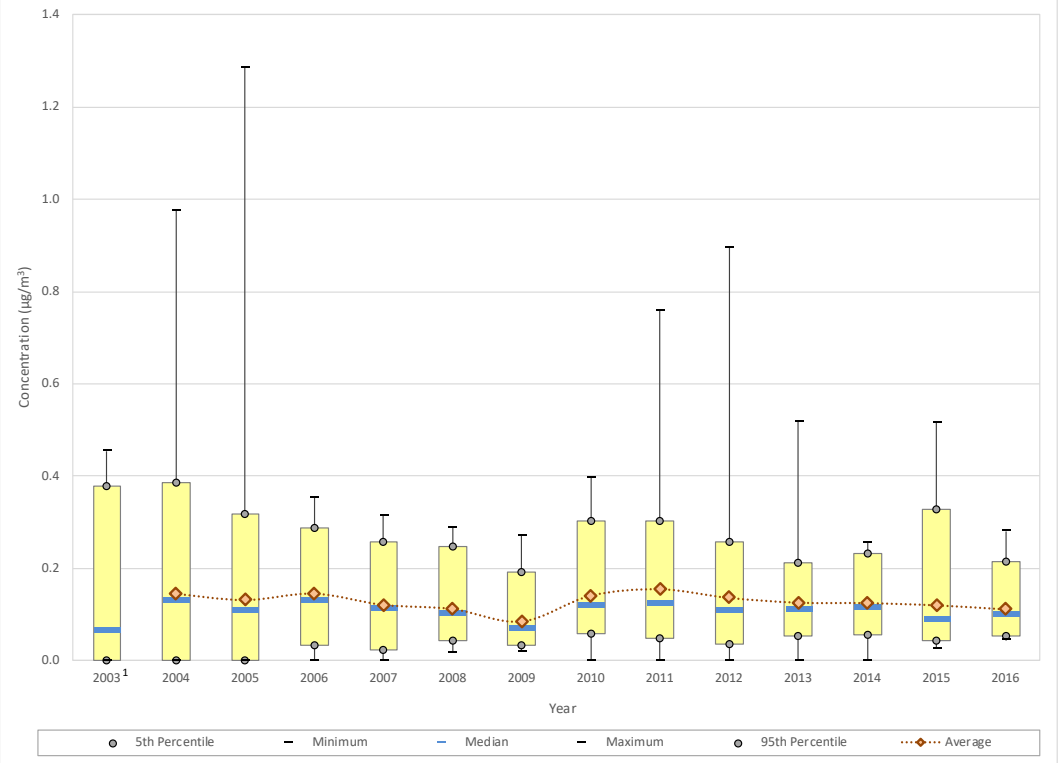
- The 1-year average benzene concentration has a significant decreasing trend between 2004 and 2009, decreasing from 1.52 µg/m^3 to 0.68 µg/m^3 during this time.

- The 1-year average concentration increased significantly from 2009 to 2010. While the maximum concentration measured changed little between these two years, five concentrations measured in 2009 are less than the minimum concentration measured in 2010. In addition, the number of benzene concentrations greater than 1 µg/m^3 increased from five in 2009 to 19 in 2010.

- Between 2010 and 2014, the 1-year average benzene concentration has an undulating pattern, varying between 0.74 µg/m^3 (2013) and 0.95 µg/m^3 (2012). The majority of benzene concentrations measured at SPIL, as indicated by the 5th and 95th percentiles, fell within roughly the same range between 2010 and 2014, with the exception of 2013, when the range of benzene concentrations is slightly smaller than other recent years.

- The decreasing trend in benzene concentrations resumed at SPIL after 2014. The range of benzene concentrations measured is smallest for 2016, with just over 1 µg/m^3 separating the minimum and maximum benzene concentrations. Further, several of the statistical parameters are at a minimum for 2016, including the 1-year average concentration.

Figure 10-33. Yearly Statistical Metrics for 1,3-Butadiene Concentrations Measured at SPIL



[1] A 1-year average is not presented because sampling under the NMP did not begin until April 2003.

Observations from Figure 10-33 for 1,3-butadiene measurements at SPIL include the following:

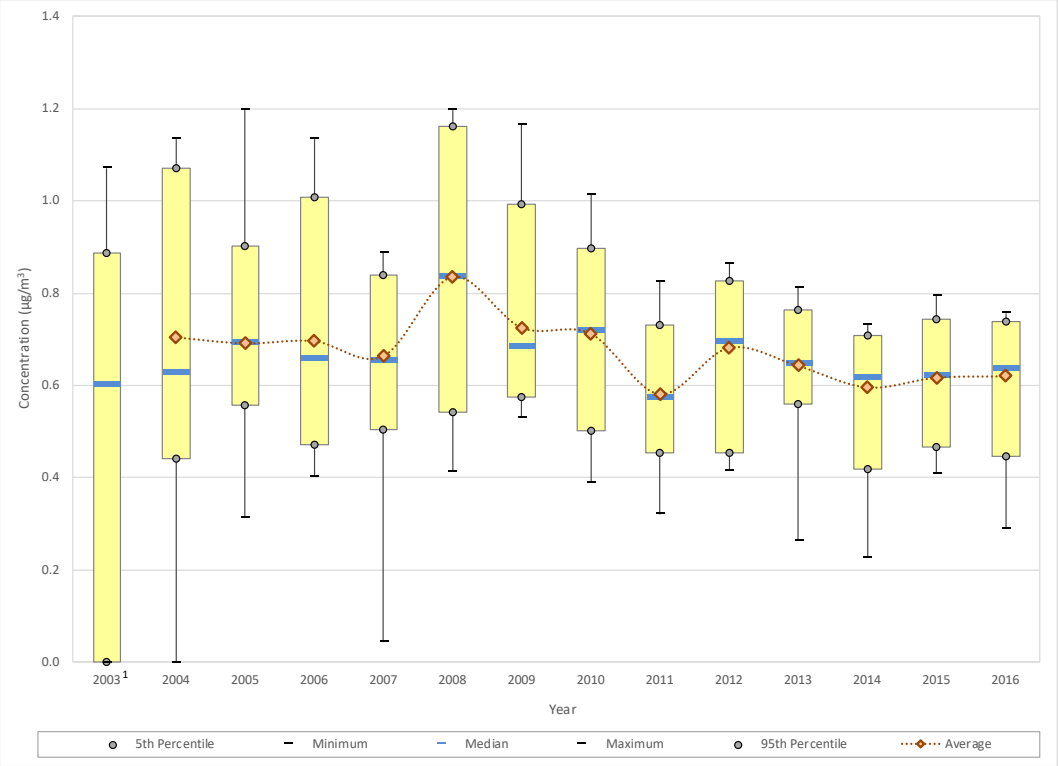
- The maximum concentration of 1,3-butadiene was measured on February 3, 2005 (1.29 µg/m^3) and is the only measurement greater than 1 µg/m^3 measured at SPIL. In total, eight concentrations greater than 0.5 µg/m^3 have been measured at SPIL, one in 2004, two in 2005, two in 2011, and one each in 2012, 2013, and 2015.

- The detection rate for 1,3-butadiene increased over the first several years of sampling; beginning with the first full year of sampling, the detection rate increased from 54 percent measured detections in 2004 to a 100 percent detection rate in 2008. Between 2007 and 2016, no more than one non-detect was measured in any given year, with the detection rate varying between 98 percent and 100 percent.

- The 1-year average concentration of 1,3-butadiene changed little between 2004 and 2006, then decreased significantly between 2006 and 2009. The significant increase in the 1-year average concentration from 2009 to 2010 represents a 67 percent increase and a return to 2006 levels. The slight increase in the 1-year average concentration for 2011 is mostly attributable to a couple higher concentrations measured (compared to 2010, as their concentration profiles are fairly similar to each other). The 1-year average concentration decreases slightly each year after 2011.

- Despite these changes, most of the 1-year average concentrations shown fall between 0.10 µg/m^3 and 0.15 µg/m^3, with only the minimum 1-year average concentration (0.08 µg/m^3 for 2009) and maximum 1-year average (0.16 µg/m^3 for 2011) falling outside this range.

Figure 10-34. Yearly Statistical Metrics for Carbon Tetrachloride Concentrations Measured at SPIL



[1] A 1-year average is not presented because sampling under the NMP did not begin until April 2003.

Observations from Figure 10-34 for carbon tetrachloride concentrations measured at SPIL include the following:

- The maximum concentration of carbon tetrachloride (1.20 µg/m^3) was measured three times, once in 2005 and twice in 2008.

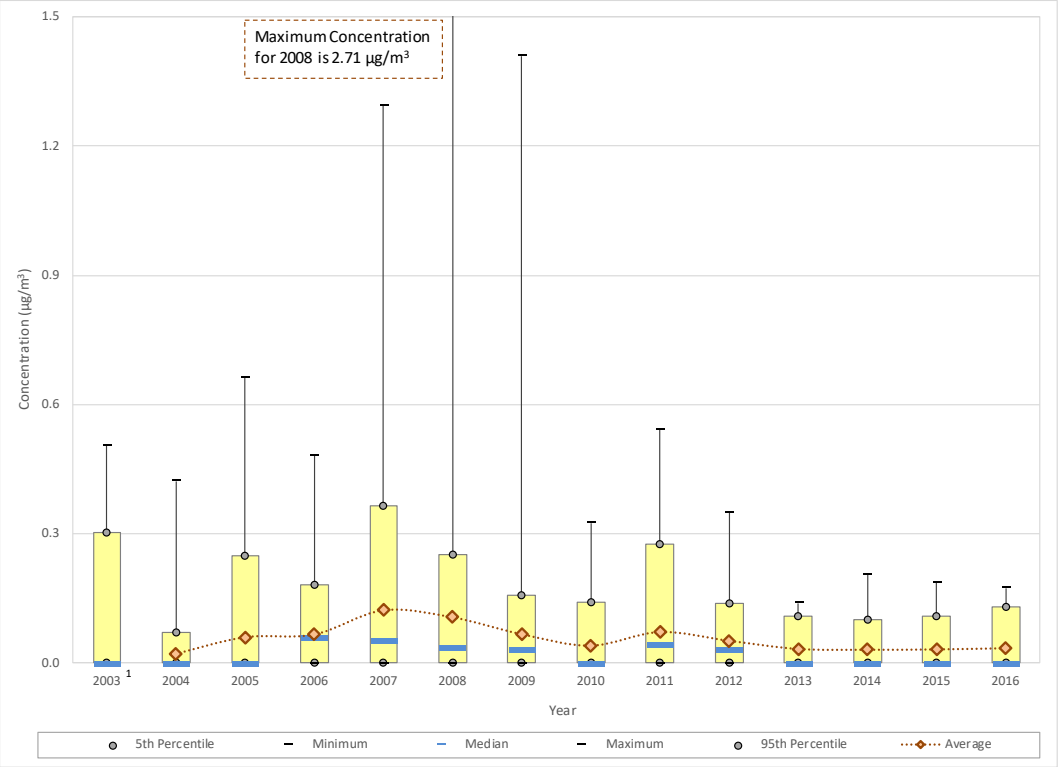
- Six non-detects of carbon tetrachloride have been measured at SPIL. All of these were measured during the first 2 years of sampling (four in 2003 and two in 2004).

- The 1-year average concentration changed very little between 2004 and 2007, varying between 0.65 µg/m^3 and 0.70 µg/m^3. The 1-year average then increased significantly for 2008 (0.84 µg/m^3). The maximum concentration was measured twice in 2008, along with nine other concentrations greater than 1 µg/m^3; 21 carbon tetrachloride concentrations measured in 2008 were greater than or equal to the maximum concentration measured in 2007 (0.89 µg/m^3).

- The 1-year average concentration exhibits a decreasing trend after 2008 that continued through 2011, when the 1-year average is at a minimum (0.58 µg/m^3). The increase shown for 2012 brings the 1-year average carbon tetrachloride concentration back to near 2010 levels.

- Most of the statistical parameters exhibit a decrease for 2013 and all of them exhibit additional decreases for 2014. Carbon tetrachloride concentrations measured at SPIL level out for 2015 and 2016.

Figure 10-35. Yearly Statistical Metrics for *p*-Dichlorobenzene Concentrations Measured at SPIL



[1] A 1-year average is not presented because sampling under the NMP did not begin until April 2003.

Observations from Figure 10-35 for *p*-dichlorobenzene concentrations measured at SPIL include the following:

- The only *p*-dichlorobenzene concentrations greater than 1 µg/m^3 were measured at SPIL during a 3-year period between 2007 and 2009.

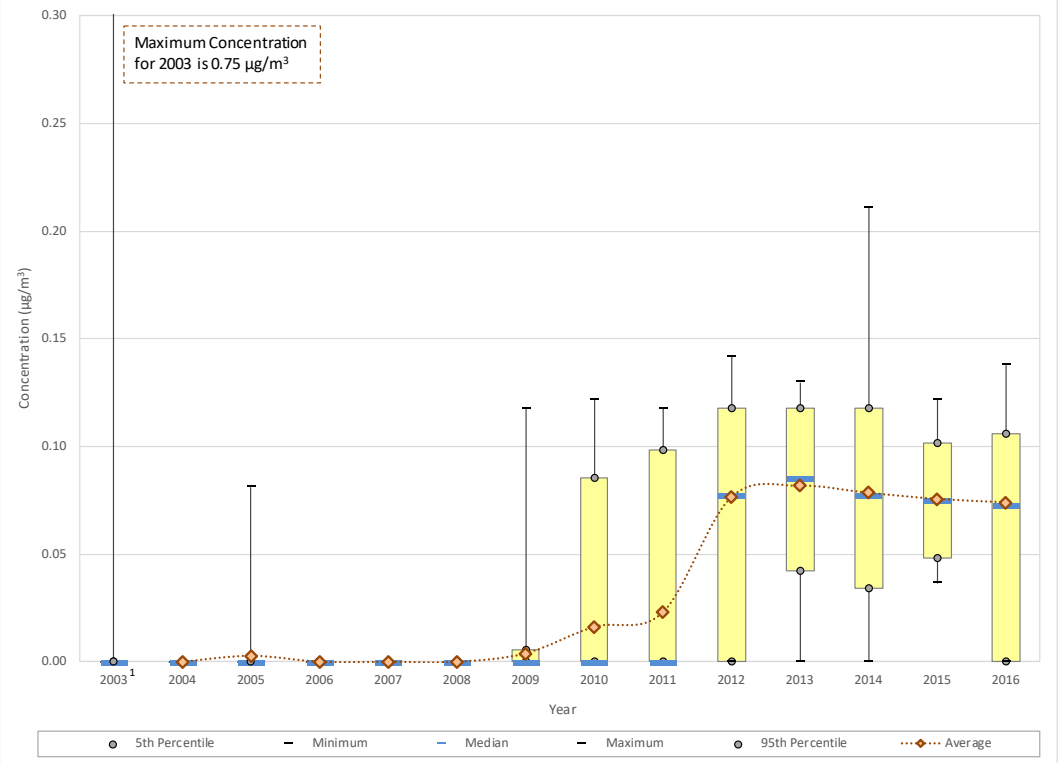
- The minimum, 5th percentile, and median concentration is zero for the first three years of sampling due to the presence of non-detects (at least half the measurements). This is also true for 2010, and 2013 through 2016. The percentage of non-detects has varied from as little as 16 percent (2007) to as high as 95 percent (2004).

- The 1-year average concentration exhibits an increasing trend between 2004 and 2007; the number of *p*-dichlorobenzene greater than 0.1 µg/m^3 increased each year during this time, from three in 2004 to 19 for 2007.

- A decreasing trend in the 1-year average concentration is shown between 2007 and 2010, when the number of non-detects again exceeds 50 percent (and the median concentration returns to zero).

- Most of the statistical parameters exhibit increases again in 2011, due to a few higher concentrations, fewer non-detects, and twice the number of *p*-dichlorobenzene concentrations greater than 0.1 µg/m^3 compared to 2010. Additional decreases are exhibited in 2012 and 2013, after which there is little change through 2016.

Figure 10-36. Yearly Statistical Metrics for 1,2-Dichloroethane Concentrations Measured at SPIL



[1] A 1-year average is not presented because sampling under the NMP did not begin until April 2003.

Observations from Figure 10-36 for 1,2-dichloroethane concentrations measured at SPIL include the following:

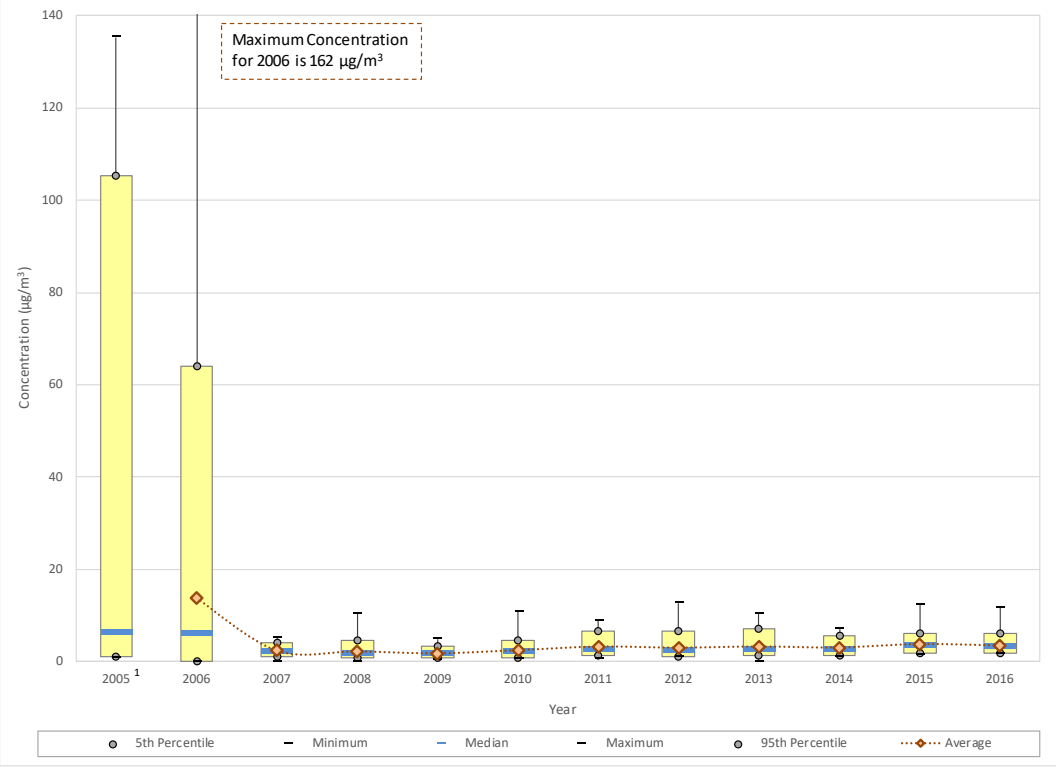
- There were no measured detections of 1,2-dichloroethane in 2004, 2006, 2007, or 2008. For 2003, 2005, and 2009, the percentage of non-detects was 95 percent or greater. Thus, the minimum, 5th percentile, median, and in some cases, the 1-year average concentrations are zero through 2009. The median concentration is also zero for 2010 and 2011, indicating that at least half the measurements are non-detects. The percentage of non-detects decreased to 80 percent for 2010 and 73 percent for 2011. After 2011, the percentage of non-detects decreased significantly, with only a few non-detects measured each year, with the exception of 2015, when non-detects were not measured.

- The maximum concentration of 1,2-dichloroethane was measured at SPIL in 2003 (0.75 µg/m^3). This is the only measured detection for 2003 as all other measurements were non-detects. Only one other 1,2-dichloroethane concentration greater than 0.15 µg/m^3 has been measured at SPIL (0.21 µg/m^3, which was measured in 2014).

- As the number of non-detects decreased and the number of measured detections increased, the statistical parameters began to increase correspondingly. The median concentration is greater than zero for the first time for 2012. The sharp decrease in the number of non-detects from 73 percent to 8 percent from 2011 to 2012 results in a sharp increase in both the 1-year average and median concentrations shown for 2012. With even fewer non-detects measured in 2013 and the highest number of 1,2-dichloroethane concentrations greater than 0.1 µg/m^3 (16), both the 1-year average and median concentrations are at a maximum for 2013.

- Both the 1-year average and median concentrations exhibit decreases between 2013 and 2016. However, the 1-year average concentrations vary by less than 0.01 µg/m^3 during this time, and the median concentrations vary by less than 0.015 µg/m^3.

Figure 10-37. Yearly Statistical Metrics for Formaldehyde Concentrations Measured at SPIL



[1] A 1-year average is not presented because consistent sampling did not begin until March 2005.

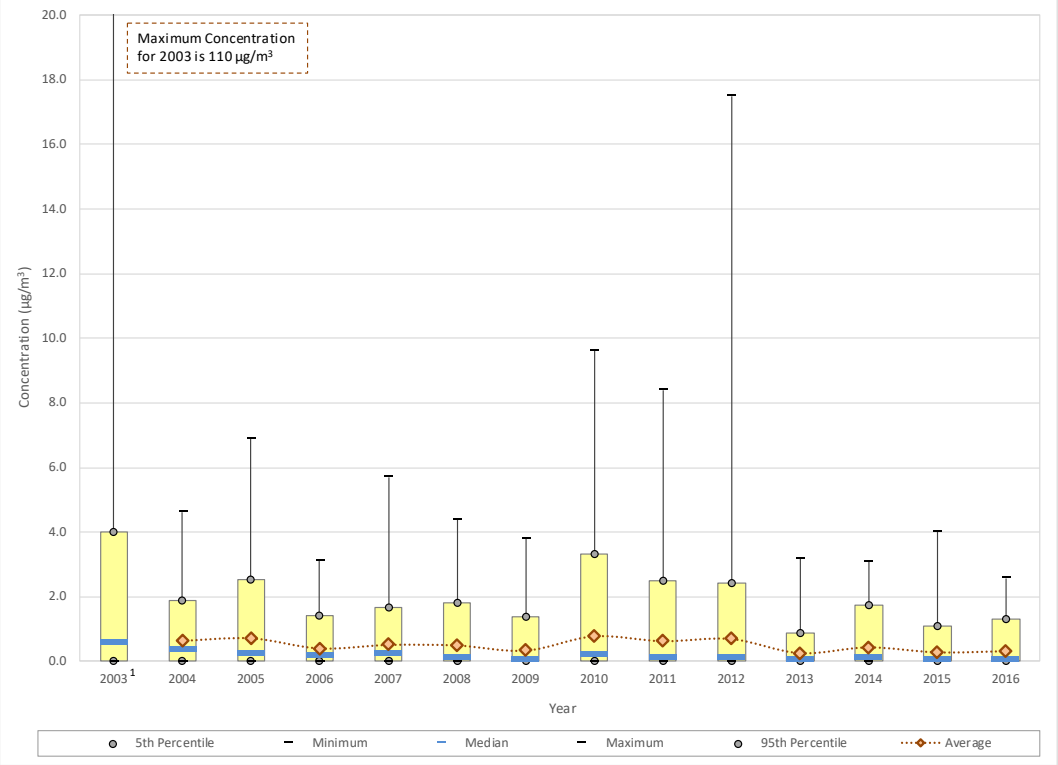
Observations from Figure 10-37 for formaldehyde concentrations measured at SPIL include the following:

- The maximum formaldehyde concentration (162 µg/m^3) was measured at SPIL on May 29, 2006 and is more than 10 times the maximum concentration for the other years shown in Figure 10-37 other than 2005. Of the 29 formaldehyde concentrations greater than 15 µg/m^3, 12 were measured at SPIL in 2005, 17 were measured in 2006, and none were measured in the years that followed.

- The 1-year average concentration for 2006 is 13.76 µg/m^3. After 2006, the 1-year average concentration decreased each year through 2009, reaching a minimum of 1.85 µg/m^3.

- There is an increasing trend in the 1-year average concentration between 2009 and 2011, after which little change is shown through 2014. The change in the 1-year average concentration between 2014 and 2015 is the largest in several years, but is not statistically significant. Between 2011 and 2016, the 1-year average concentrations varied between 3.07 µg/m^3 (2012) and 3.85 µg/m^3 (2016).

Figure 10-38. Yearly Statistical Metrics for Trichloroethylene Concentrations Measured at SPIL



[1] A 1-year average is not presented because sampling under the NMP did not begin until April 2003.

Observations from Figure 10-38 for trichloroethylene concentrations measured at SPIL include the following:

- The minimum and 5th percentile are both zero for all years of sampling, indicating that at least 5 percent of the measurements were non-detects for each year since sampling began at SPIL. The percentage of non-detects has ranged from 13 percent (2014) to 39 percent (2004).

- The maximum concentration of trichloroethylene (110 µg/m^3) was measured at SPIL in 2003 and is an order of magnitude greater than the next highest concentration (17.5 µg/m^3), which was measured in 2012. No other trichloroethylene concentrations greater than 10 µg/m^3 have been measured at SPIL.

- The concentrations of trichloroethylene exhibit considerable variability, as indicated by confidence intervals calculated for the 1-year average concentrations, particularly for 2012, when the maximum concentration was nearly four times the next highest concentration measured that year and non-detects made up about one-fifth of the measurements.

- The 1-year average concentrations have fluctuated between 0.26 µg/m^3 (2013) and 0.79 µg/m^3 (2010), with no distinct trend in the concentrations. The median concentration, however, has varied relatively little since 2011, ranging from 0.10 µg/m^3 (2013) to 0.15 µg/m^3 (2011, 2014) during this time.

10.4 Additional Risk-Based Screening Evaluations

The following risk-based screening evaluations were conducted to characterize risk related to the air toxics measured at each Illinois monitoring site. Refer to Sections 3.2, 3.4.2.3, and 3.4.2.4 for definitions and explanations regarding the various toxicity factors, time frames, and calculations associated with these risk-based screenings.

10.4.1 Cancer Risk and Noncancer Hazard Approximations

For the pollutants of interest for the Illinois sites, risk was examined by calculating cancer risk and noncancer hazard approximations for each year annual average concentrations could be calculated. These approximations can be used as risk estimates for cancer and noncancer effects attributable to the pollutants of interest. Although the use of these approximations is limited, they may help identify where policy-makers want to shift their air monitoring priorities. Refer to Section 3.4.2.3 for an explanation of how cancer risk and noncancer hazard approximations are calculated and what limitations are associated with them. Annual averages, cancer UREs and/or noncancer RfCs, and cancer risk and noncancer hazard approximations are presented in Table 10-4, where applicable. Cancer risk approximations are presented as probabilities while the noncancer hazard approximations are ratios and thus, unitless values.

Table 10-4. Risk Approximations for the Illinois Monitoring Sites

Pollutant	Cancer URE ($\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	2015				2016			
			# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Risk Approximations		# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Risk Approximations	
					Cancer (in-a-million)	Noncancer (HQ)			Cancer (in-a-million)	Noncancer (HQ)
Northbrook, Illinois - NBIL										
Acetaldehyde	0.0000022	0.009	57/57	1.42 ± 0.16	3.13	0.16	59/59	1.47 ± 0.21	3.23	0.16
Benzene	0.0000078	0.03	54/54	0.52 ± 0.06	4.03	0.02	59/59	0.43 ± 0.04	3.38	0.01
1,3-Butadiene	0.00003	0.002	51/54	0.04 ± 0.01	1.20	0.02	56/59	0.04 ± 0.01	1.10	0.02
Carbon Tetrachloride	0.000006	0.1	54/54	0.63 ± 0.03	3.79	0.01	59/59	0.56 ± 0.04	3.38	0.01
p-Dichlorobenzene	0.000011	0.8	27/54	0.13 ± 0.11	1.47	<0.01	23/59	0.03 ± 0.01	0.35	<0.01
1,2-Dichloroethane	0.000026	2.4	53/54	0.07 ± <0.01	1.81	<0.01	50/59	0.07 ± 0.01	1.79	<0.01
Formaldehyde	0.000013	0.0098	57/57	2.03 ± 0.25	26.40	0.21	59/59	2.16 ± 0.39	28.12	0.22
Acenaphthene[a]	0.000088	--	55/60	17.48 ± 5.87	1.54	--	55/56	18.93 ± 6.15	1.67	--
Arsenic (PM_{10})[a]	0.0043	0.000015	56/56	0.94 ± 0.27	4.04	0.06	57/57	0.87 ± 0.13	3.74	0.06
Fluoranthene[a]	0.000088	--	60/60	8.82 ± 2.90	0.78	--	56/56	11.38 ± 3.85	1.00	--
Fluorene[a]	0.000088	--	53/60	16.27 ± 5.41	1.43	--	51/56	19.19 ± 6.42	1.69	--
Naphthalene[a]	0.000034	0.003	60/60	89.32 ± 22.07	3.04	0.03	56/56	79.55 ± 17.47	2.70	0.03

-- = a Cancer URE or Noncancer RfC is not available.

[a] Average concentrations provided below the blue line for this site and/or pollutant are presented in ng/m^3 for ease of viewing.

NA = Not available because the criteria for calculating an annual average were not met.

NS = Sampling was not conducted during this time.

Table 10-4. Risk Approximations for the Illinois Monitoring Sites (Continued)

Pollutant	Cancer URE ($\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	2015				2016			
			# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Risk Approximations		# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Risk Approximations	
					Cancer (in-a-million)	Noncancer (HQ)			Cancer (in-a-million)	Noncancer (HQ)
Schiller Park, Illinois - SPIL										
Acetaldehyde	0.0000022	0.009	61/61	2.43 ± 0.52	5.35	0.27	57/57	2.45 ± 0.61	5.38	0.27
Benzene	0.0000078	0.03	60/60	0.71 ± 0.10	5.52	0.02	58/58	0.63 ± 0.05	4.92	0.02
1,3-Butadiene	0.00003	0.002	60/60	0.12 ± 0.02	3.62	0.06	58/58	0.11 ± 0.01	3.35	0.06
Carbon Tetrachloride	0.000006	0.1	60/60	0.62 ± 0.02	3.70	0.01	58/58	0.62 ± 0.03	3.72	0.01
p-Dichlorobenzene	0.000011	0.8	25/60	0.03 ± 0.01	0.35	<0.01	25/58	0.03 ± 0.01	0.38	<0.01
1,2-Dichloroethane	0.000026	2.4	60/60	0.08 ± <0.01	1.97	<0.01	54/58	0.07 ± 0.01	1.92	<0.01
Formaldehyde	0.000013	0.0098	61/61	3.85 ± 0.45	50.00	0.39	57/57	3.54 ± 0.47	45.98	0.36
Trichloroethylene	0.0000048	0.002	42/60	0.29 ± 0.16	1.37	0.14	48/58	0.32 ± 0.13	1.54	0.16

-- = a Cancer URE or Noncancer RfC is not available.

[a] Average concentrations provided below the blue line for this site and/or pollutant are presented in ng/m^3 for ease of viewing.

NA = Not available because the criteria for calculating an annual average were not met.

NS = Sampling was not conducted during this time.

Table 10-4. Risk Approximations for the Illinois Monitoring Sites (Continued)

Pollutant	Cancer URE ($\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	2015				2016			
			# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Risk Approximations		# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Risk Approximations	
					Cancer (in-a-million)	Noncancer (HQ)			Cancer (in-a-million)	Noncancer (HQ)
Roxana, Illinois - ROIL										
Acetaldehyde	0.0000022	0.009	33/33	NA	NA	NA	NS	NS	NS	NS
Benzene	0.0000078	0.03	32/32	NA	NA	NA	NS	NS	NS	NS
1,3-Butadiene	0.00003	0.002	30/32	NA	NA	NA	NS	NS	NS	NS
Carbon Tetrachloride	0.000006	0.1	32/32	NA	NA	NA	NS	NS	NS	NS
1,2-Dichloroethane	0.000026	2.4	31/32	NA	NA	NA	NS	NS	NS	NS
Formaldehyde	0.000013	0.0098	33/33	NA	NA	NA	NS	NS	NS	NS

-- = a Cancer URE or Noncancer RfC is not available.

[a] Average concentrations provided below the blue line for this site and/or pollutant are presented in ng/m^3 for ease of viewing.

NA = Not available because the criteria for calculating an annual average were not met.

NS = Sampling was not conducted during this time.

Observations for the Illinois sites from Table 10-4 include the following:

- Formaldehyde and acetaldehyde are the pollutants of interest with the highest annual average concentrations for NBIL and SPIL (and the only ones greater than 1 $\mu g/m^3$). The annual averages for these pollutants are significantly higher for SPIL than NBIL.

- Formaldehyde has the highest cancer risk approximations for both sites. The cancer risk approximations for SPIL (50.00 in-a-million for 2015 and 45.98 in-a-million for 2016) are greater than those calculated for NBIL (26.40 in a million for 2015 and 28.12 in-a-million for 2016). There were no other pollutants for which a cancer risk approximation greater than 10 in-a-million was calculated.

- None of the pollutants of interest for NBIL or SPIL have noncancer hazard approximations greater than 1.0, indicating that no adverse noncancer health effects are expected from these individual pollutants. The pollutant with the highest noncancer hazard approximations among the pollutants of interest for the Chicago sites is formaldehyde (an HQ of 0.39 for 2015 and 0.36 for 2016 for SPIL and an HQ of 0.21 for 2015 and 0.22 for 2016 for NBIL).

- Because annual average concentrations could not be calculated for ROIL, cancer risk and noncancer hazard approximations were not calculated for this site.

10.4.2 Risk-Based Emissions Assessment

In addition to the risk-based screening discussed above, this section presents an evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 10-5 presents the 10 pollutants with the highest emissions from the 2014 NEI (version 1) that have cancer toxicity factors. Table 10-5 also presents the 10 pollutants with the highest toxicity-weighted emissions, based on the weighting schema described in Section 3.4.2.4. Lastly, Table 10-5 provides the pollutants with the highest cancer risk approximations (in-a-million) for each Illinois site, as presented in Table 10-4. Cancer risk approximations for 2015 are presented in green while approximations for 2016 are in white. The emissions, toxicity-weighted emissions, and cancer risk approximations are shown in descending order in Table 10-5. Table 10-6 presents similar information, but is limited to those pollutants with noncancer toxicity factors.

Table 10-5. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Illinois Monitoring Sites

Top 10 Total Emissions for Pollutants with Cancer UREs (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Annual Average Concentrations (Site-Specific) [1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Northbrook, Illinois (Cook County) - NBIL					
Benzene	1,084.36	Formaldehyde	1.28E-02	Formaldehyde	28.12
Formaldehyde	985.00	Naphthalene	9.29E-03	Formaldehyde	26.40
Ethylbenzene	648.33	Benzene	8.46E-03	Arsenic	4.04
Acetaldehyde	549.09	1,3-Butadiene	5.36E-03	Benzene	4.03
Naphthalene	273.18	Hexavalent Chromium, PM	4.67E-03	Carbon Tetrachloride	3.79
Tetrachloroethylene	207.13	Ethylene oxide	3.81E-03	Arsenic	3.74
1,3-Butadiene	178.79	POM, Group 2b	1.83E-03	Benzene	3.38
Trichloroethylene	59.27	Ethylbenzene	1.62E-03	Carbon Tetrachloride	3.38
Dichloromethane	37.59	POM, Group 2d	1.32E-03	Acetaldehyde	3.23
POM, Group 2b	20.80	POM, Group 5a	1.26E-03	Acetaldehyde	3.13
Schiller Park, Illinois (Cook County) - SPIL					
Benzene	1,084.36	Formaldehyde	1.28E-02	Formaldehyde	50.00
Formaldehyde	985.00	Naphthalene	9.29E-03	Formaldehyde	45.98
Ethylbenzene	648.33	Benzene	8.46E-03	Benzene	5.52
Acetaldehyde	549.09	1,3-Butadiene	5.36E-03	Acetaldehyde	5.38
Naphthalene	273.18	Hexavalent Chromium, PM	4.67E-03	Acetaldehyde	5.35
Tetrachloroethylene	207.13	Ethylene oxide	3.81E-03	Benzene	4.92
1,3-Butadiene	178.79	POM, Group 2b	1.83E-03	Carbon Tetrachloride	3.72
Trichloroethylene	59.27	Ethylbenzene	1.62E-03	Carbon Tetrachloride	3.70
Dichloromethane	37.59	POM, Group 2d	1.32E-03	1,3-Butadiene	3.62
POM, Group 2b	20.80	POM, Group 5a	1.26E-03	1,3-Butadiene	3.35

[1] Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Table 10-5. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Illinois Monitoring Sites (Continued)

Top 10 Total Emissions for Pollutants with Cancer UREs (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Annual Average Concentrations (Site-Specific) [1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Roxana, Illinois (Madison County) - ROIL					
Formaldehyde	128.06	Coke Oven Emissions, PM	2.96E-02		
Benzene	126.13	Formaldehyde	1.66E-03		
Ethylbenzene	58.76	Hexavalent Chromium, PM	1.35E-03		
Acetaldehyde	50.92	Naphthalene	9.90E-04		
Coke Oven Emissions, PM	29.89	Benzene	9.84E-04		
Naphthalene	29.11	Arsenic, PM	5.88E-04		
1,3-Butadiene	13.46	Ethylene oxide	4.13E-04		
POM, Group 2b	2.19	1,3-Butadiene	4.04E-04		
Tetrachloroethylene	1.63	POM, Group 5a	3.39E-04		
POM, Group 2d	1.57	POM, Group 2b	1.93E-04		

[1] Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Table 10-6. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the Illinois Monitoring Sites

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific) [1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Hazard Approximation (HQ)**
Northbrook, Illinois (Cook County) - NBIL					
Ethylene glycol	6,317.67	Acrolein	4,321,056.56	Formaldehyde	0.22
Toluene	4,302.61	Cyanide Compounds, gas	122,716.64	Formaldehyde	0.21
Xylenes	2,428.56	Formaldehyde	100,510.67	Acetaldehyde	0.16
Methanol	2,242.96	Naphthalene	91,058.85	Acetaldehyde	0.16
Hexane	1,430.98	1,3-Butadiene	89,397.31	Arsenic	0.06
Benzene	1,084.36	Acetaldehyde	61,009.94	Arsenic	0.06
Formaldehyde	985.00	Cadmium, PM	55,856.40	Naphthalene	0.03
Ethylbenzene	648.33	Maleic anhydride	37,745.29	Naphthalene	0.03
Acetaldehyde	549.09	Benzene	36,145.42	1,3-Butadiene	0.02
Glycol ethers, gas	356.93	Trichloroethylene	29,634.05	1,3-Butadiene	0.02
Schiller Park, Illinois (Cook County) - SPIL					
Ethylene glycol	6,317.67	Acrolein	4,321,056.56	Formaldehyde	0.39
Toluene	4,302.61	Cyanide Compounds, gas	122,716.64	Formaldehyde	0.36
Xylenes	2,428.56	Formaldehyde	100,510.67	Acetaldehyde	0.27
Methanol	2,242.96	Naphthalene	91,058.85	Acetaldehyde	0.27
Hexane	1,430.98	1,3-Butadiene	89,397.31	Trichloroethylene	0.16
Benzene	1,084.36	Acetaldehyde	61,009.94	Trichloroethylene	0.14
Formaldehyde	985.00	Cadmium, PM	55,856.40	1,3-Butadiene	0.06
Ethylbenzene	648.33	Maleic anhydride	37,745.29	1,3-Butadiene	0.06
Acetaldehyde	549.09	Benzene	36,145.42	Benzene	0.02
Glycol ethers, gas	356.93	Trichloroethylene	29,634.05	Benzene	0.02

[1] Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Table 10-6. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the Illinois Monitoring Sites (Continued)

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Hazard Approximation (HQ)**
Roxana, Illinois (Madison County) - ROIL					
Toluene	355.12	Acrolein	365,050.42		
Ethylene glycol	320.64	Chlorine	90,642.90		
Xylenes	211.91	Manganese, PM	15,961.75		
Hydrochloric acid	149.65	Cyanide Compounds, gas	13,584.64		
Methanol	131.56	Formaldehyde	13,067.65		
Formaldehyde	128.06	Lead, PM	10,007.39		
Benzene	126.13	Naphthalene	9,704.69		
Hexane	119.93	Arsenic, PM	9,109.27		
Ethylbenzene	58.76	Hydrochloric acid	7,482.26		
Acetaldehyde	50.92	Cyanide Compounds, PM	7,297.86		

[1] Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Because not all pollutants have both cancer and noncancer toxicity factors, the highest emitted pollutants in the cancer table may be different from the noncancer table, although the actual quantity of emissions is the same. The cancer risk and noncancer hazard approximations based on each site's annual averages are limited to the pollutants of interest identified for each site. In addition, the cancer risk and noncancer hazard approximations are limited to those pollutants with enough data to meet the criteria for annual averages to be calculated. A more in-depth discussion of this analysis is provided in Section 3.4.2.4. Similar to the cancer risk and noncancer hazard approximations provided in Section 10.4.1, this analysis may help policy-makers prioritize their air monitoring activities.

Observations from Table 10-5 include the following:

- Benzene, formaldehyde, and ethylbenzene are the highest emitted pollutants with cancer UREs in Cook County. These same pollutants are the highest emitted pollutants with cancer UREs in Madison County, although the order differs. The quantity of emissions is considerably different between the two counties, with the emissions for Cook County up to an order of magnitude greater than Madison County.

- The pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) for Cook County are formaldehyde, naphthalene, and benzene. Coke oven emissions top Madison County's toxicity-weighted emissions, followed by formaldehyde and hexavalent chromium.

- Six of the highest emitted pollutants in Cook County also have the highest toxicity-weighted emissions. Six of the highest emitted pollutants in Madison County also have the highest toxicity-weighted emissions, though the exact pollutants differ between the counties.

- For NBIL and SPIL, formaldehyde is the pollutant with the highest cancer risk approximations. This pollutant also has the highest toxicity-weighted emissions and ranks second for quantity emitted in Cook County. Benzene also appears on all three lists for both sites. 1,3-Butadiene also appears on all three lists for SPIL; 1,3-butadiene is also a pollutant of interest for NBIL, although its cancer risk approximations are lower than those shown in Table 10-5. Acetaldehyde is among the pollutants with the highest cancer risk approximations for both NBIL and SPIL; while acetaldehyde is among the highest emitted pollutants in Cook County, it is not among those with the highest toxicity-weighted emissions.

- Carbon tetrachloride is among the pollutants with the highest cancer risk approximations for both NBIL and SPIL, yet does not appear on either of Cook County's emissions-based lists. Carbon tetrachloride ranks 23rd in Cook County for the quantity emitted and 33rd for its toxicity-weighted emissions.

- Similarly, arsenic is among the pollutants with the highest cancer risk approximations for NBIL yet does not appear on either of Cook County's emissions-based lists. Arsenic ranks 24th for its emissions in Cook County and ranks 14th for its toxicity-weighted emissions.

- Naphthalene has the second highest toxicity-weighted emissions for Cook County and ranks fifth for quantity emitted. While naphthalene is also a pollutant of interest for NBIL, its cancer risk approximations are lower than those shown in Table 10-5. POM, Group 2b ranks 10th for quantity emitted and seventh for toxicity-weighted emissions in Cook County. POM, Group 2b includes acenaphthene, fluorene, and fluoranthene, all three of which are pollutants of interest for NBIL.

- Trichloroethylene, which is a pollutant of interest only for SPIL, is the eighth highest emitted pollutant in Cook County, but does not appear among the pollutants with the highest toxicity-weighted emissions (this pollutant ranks 17th).

Observations from Table 10-6 include the following:

- Ethylene glycol, toluene, and xylenes are the highest emitted pollutants with noncancer RfCs in Cook County. These same pollutants are the highest emitted pollutants with noncancer RfCs in Madison County, although the order differs. The quantity emitted is significantly higher in Cook County.

- The pollutant with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) for both counties is acrolein. Although acrolein was sampled for at all three sites, this pollutant was excluded from the pollutants of interest designation, and thus subsequent risk-based screening evaluations, due to questions about the consistency and reliability of the measurements, as discussed in Section 3.2.

- Only three of the highest emitted pollutants also have the highest toxicity-weighted emissions for Cook County (formaldehyde, benzene, and acetaldehyde). The highest emitted pollutants and the pollutants with the highest toxicity-weighted emissions for Madison County have only two pollutants in common (formaldehyde and hydrochloric acid). This speaks to the relative toxicity of a pollutant; a pollutant does not have to be emitted in high quantities to be hazardous to human health.

- Formaldehyde and acetaldehyde have the highest noncancer hazard approximations for the Chicago sites (albeit less than an HQ of 1.0). These two pollutants appear on both emissions-based lists for Cook County. 1,3-Butadiene also has some of the highest noncancer hazard approximations for these two sites; 1,3-butadiene is among those with the highest toxicity-weighted emissions for Cook County, but is not among the highest emitted.

- Naphthalene and arsenic are also pollutants of interest for NBIL and appear among those with highest noncancer hazard approximations for this site. Naphthalene appears among those with the highest toxicity-weighted emissions in Cook County but is not among the highest emitted. Arsenic appears on neither emissions-based list for Cook County.

- Benzene and trichloroethylene are pollutants of interest for SPIL and appear among those with highest noncancer hazard approximations for this site. Benzene appears on both emissions-based lists for Cook County. Trichloroethylene is among those with the highest toxicity-weighted emissions for Cook County but is not among the highest emitted (of the pollutants with noncancer RfCs).

10.5 Summary of the 2015-2016 Monitoring Data for NBIL, SPIL, and ROIL

Results from several of the data analyses described in this section include the following:

- ❖ *Twenty-three pollutants (two carbonyl compounds, 12 VOCs, five PAHs, and four speciated metals) failed screens for NBIL; 14 pollutants (three carbonyl compounds and 11 VOCs) failed screens for SPIL; and 10 pollutants (three carbonyl compounds and seven VOCs) failed screens for ROIL.*

- ❖ *Sampling at ROIL was discontinued at the end of July 2015, ending a four-year monitoring effort at this location.*

- ❖ *Formaldehyde had the highest annual average concentrations among the pollutants of interest for both NBIL and SPIL, although the annual averages for SPIL were higher than those calculated for NBIL.*

- ❖ *The maximum concentrations of several pollutants across the program were measured at NBIL (p-dichlorobenzene, fluoranthene, and naphthalene).*

- ❖ *After several years of increasing, concentrations of acetaldehyde decreased significantly in 2015 and 2016 at NBIL while the opposite is true of formaldehyde concentrations measured at this site. Concentrations of fluoranthene have an increasing trend at NBIL while concentrations of naphthalene have a decreasing trend. Concentrations of benzene measured at NBIL are at a minimum in 2016; this is also true at SPIL.*

- ❖ *Formaldehyde has the highest cancer risk approximation among the pollutants of interest for both Chicago sites. None of the pollutants of interest have noncancer hazard approximations greater than an HQ of 1.0.*

11.0 Sites in Indiana

This section summarizes those data from samples collected at the UATMP sites in Indiana and generated by ERG, EPA's contract laboratory for the NMP, over the 2015 and 2016 monitoring efforts. This section also examines the spatial and temporal characteristics of the ambient monitoring concentrations and reviews them through the context of risk. Readers are encouraged to refer to Sections 1 through 4 for detailed discussions and definitions regarding the various data analyses presented below.

Data generated by sources other than ERG, EPA's contract laboratory for the NMP, are not included in the data analyses contained in this report.

11.1 Site Characterization

This section characterizes the Indiana monitoring sites by providing a description of the nearby area surrounding each monitoring site; plotting emissions sources surrounding the monitoring sites; and presenting traffic data and other characterizing information for each site. This information is provided to give the reader insight regarding factors that may influence the air quality near the sites and assist in the interpretation of the ambient measurements.

One Indiana monitoring site (INDEM) is located in the Chicago-Naperville-Elgin, IL-IN-WI CBSA, and another site (WPIN) is located in the Indianapolis-Carmel-Anderson, IN CBSA. Figures 11-1 and 11-3 present composite satellite images retrieved from ArcGIS Explorer showing the monitoring sites and their immediate surroundings. Figures 11-2 and 11-4 identify nearby point source emissions locations by source category near INDEM and WPIN, respectively, as reported in the 2014 NEI for point sources, version 1. Note that only sources within 10 miles of the sites are included in the facility counts provided in Figures 11-2 and 11-4. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have a direct effect on the air quality at the monitoring sites. Further, this boundary provides both the proximity of emissions sources to the monitoring sites as well as the quantity of such sources within a given distance of the sites. Sources outside the 10-mile boundary are still visible on each map for reference, but have been grayed out to emphasize emissions sources within the boundary. Table 11-1 provides supplemental geographical information such as land use, location setting, and locational coordinates. Each figure and table is discussed in detail in the paragraphs that follow.

Figure 11-1. Gary, Indiana (INDEM) Monitoring Site

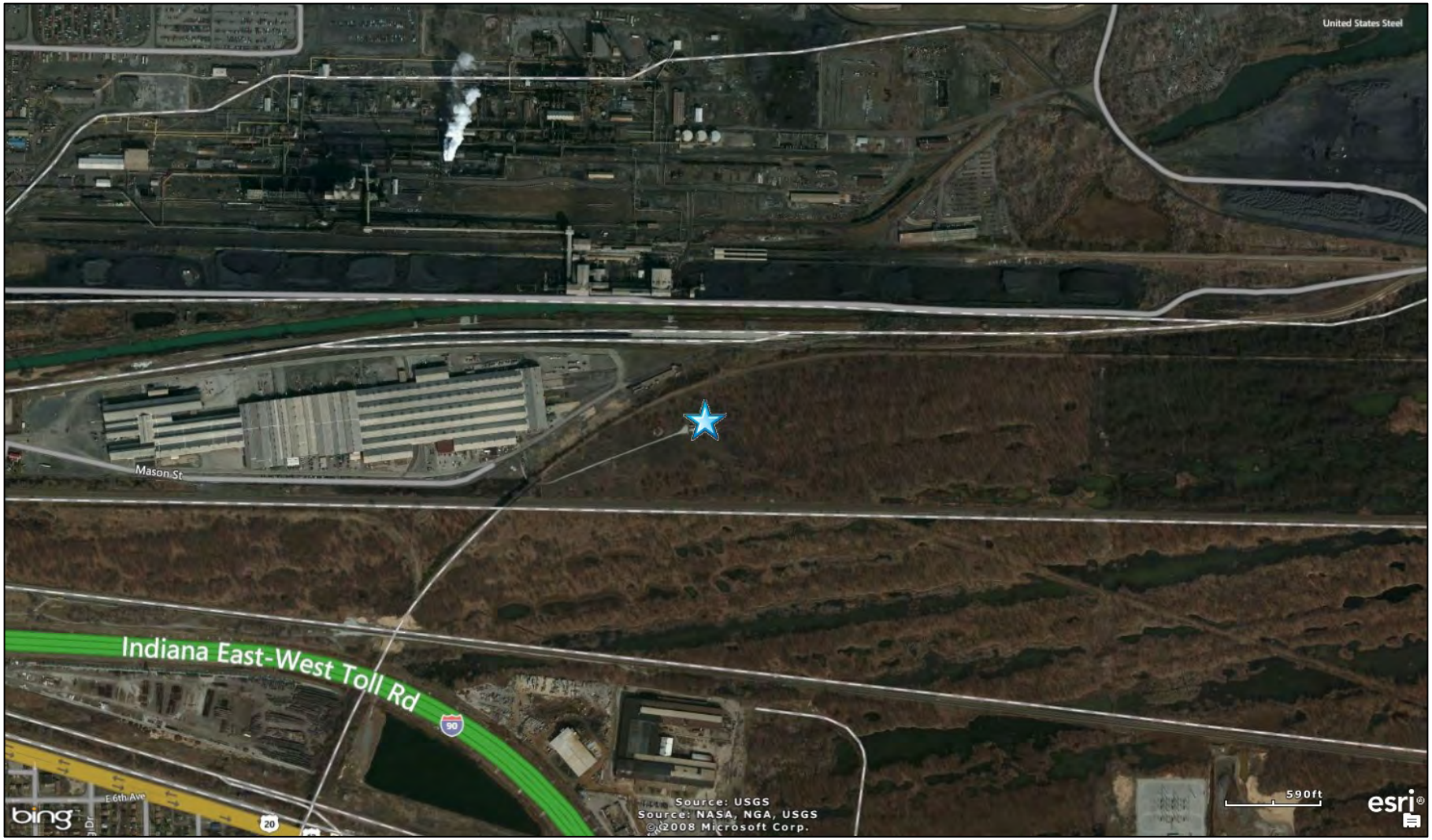


Figure 11-2. NEI Point Sources Located Within 10 Miles of INDEM

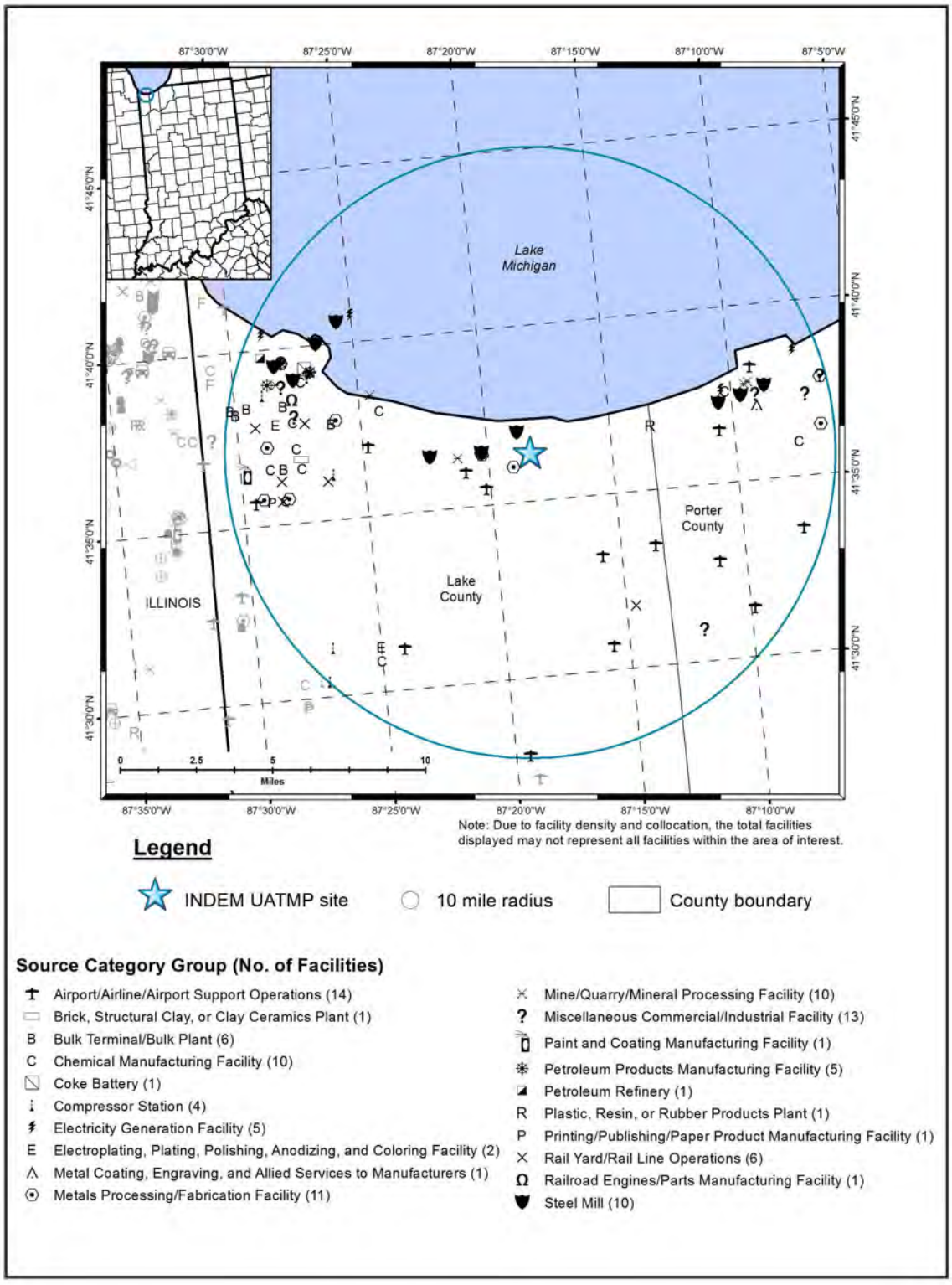


Figure 11-3. Indianapolis, Indiana (WPIN) Monitoring Site

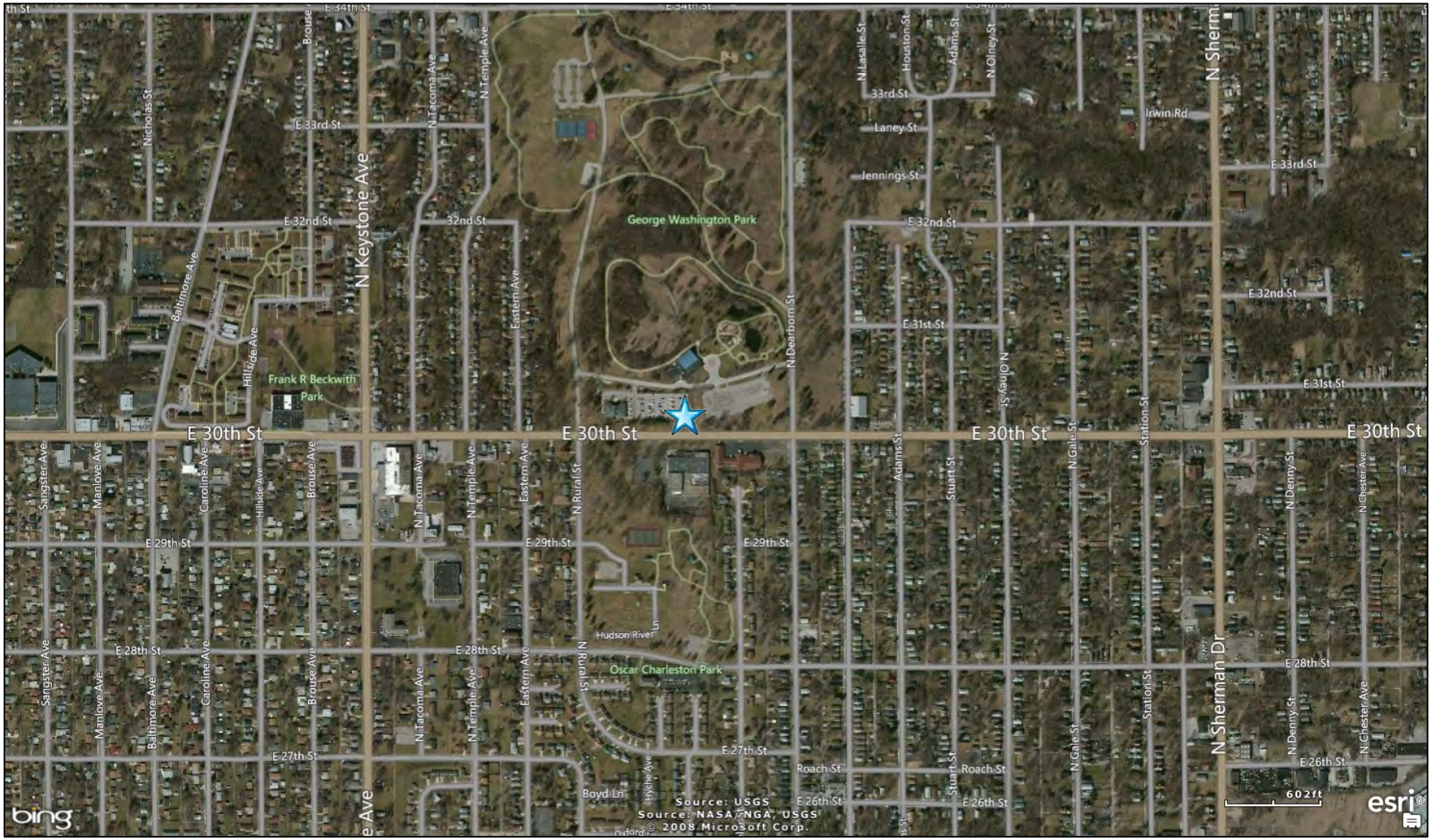


Figure 11-4. NEI Point Sources Located Within 10 Miles of WPIN

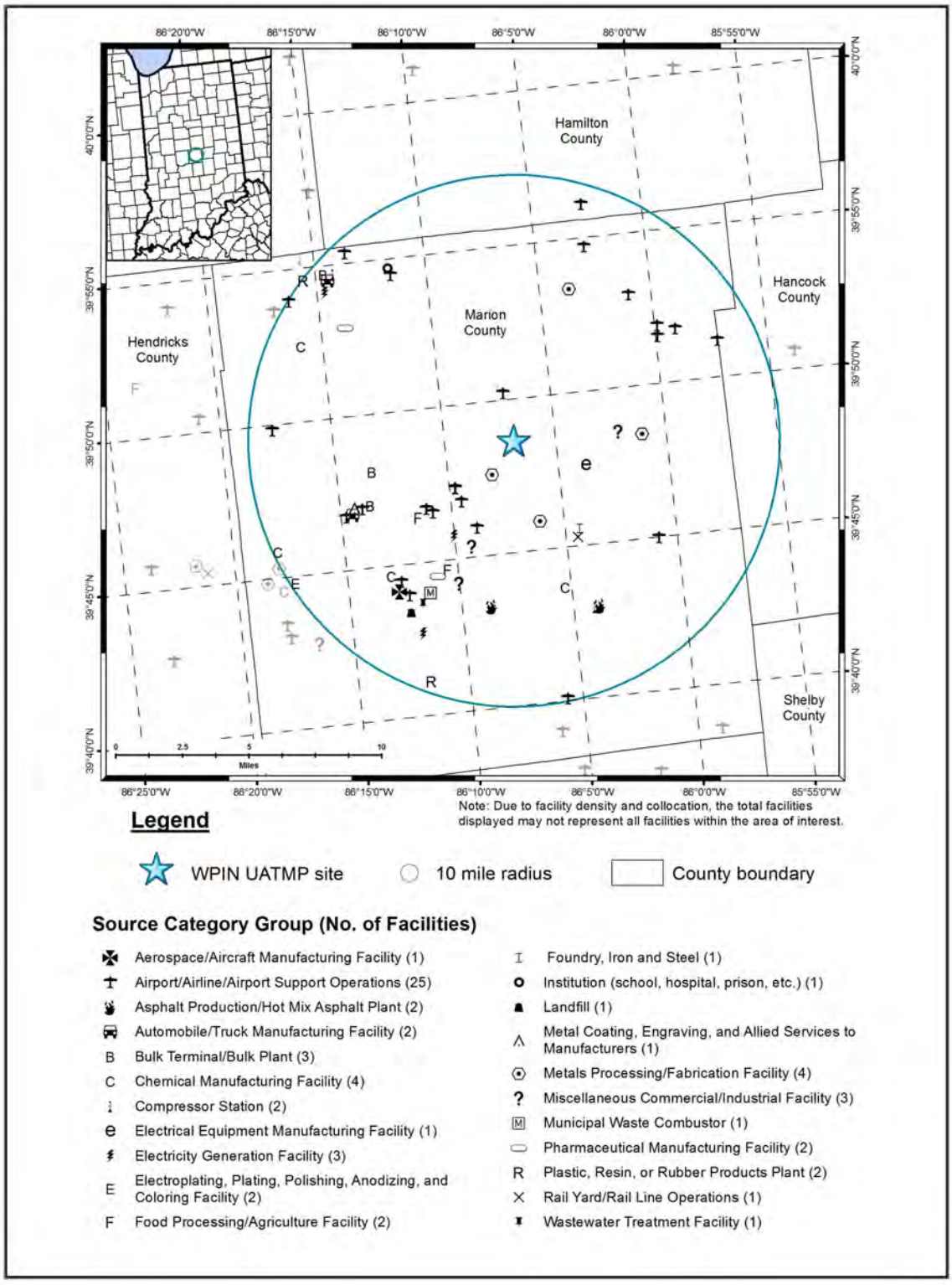


Table 11-1. Geographical Information for the Indiana Monitoring Sites

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Annual Average Daily Traffic[1]	Intersection Used for Traffic Data
INDEM	18-089-0022	Gary	Lake	Chicago- Naperville-Elgin, IL-IN-WI	41.606680, -87.304729	Industrial	Urban/City Center	41,860	I-90 N of I-65 Interchange
WPIN	18-097-0078	Indianapolis	Marion	Indianapolis-Carmel-Anderson, IN	39.811097, -86.114469	Residential	Suburban	24,917	Keystone Ave, N of 38th St

[1]AADT reflects 2016 data (IN DOT, 2016)

INDEM is located in Gary, Indiana, approximately 11 miles east of the Indiana-Illinois border, 25 miles southeast of Chicago, and on the southernmost bank of Lake Michigan. The site is located just north of I-65 and I-90, the edge of which can be seen in the bottom left portion of Figure 11-1. Although INDEM resides on the Indiana Dunes National Lakeshore, about 1 mile south of the Lake Michigan shoreline, the surrounding area is highly industrialized, as shown in Figure 11-1, and several rail lines transverse the area. Figure 11-2 shows that the majority of point sources within 10 miles of INDEM are located to the west of the site. There is also a second cluster of facilities located to the east of INDEM in Porter County. The emissions source categories with the highest number of sources within 10 miles of INDEM include aircraft operations, which includes airports and related operations as well as small runways and heliports, such as those associated with hospitals or television stations; metals processing and fabrication; steel mills; chemical manufacturing; and mine/quarry/mineral processing. The sources closest to INDEM include two steel mills; a heliport at a police station; several facilities that fall into the miscellaneous commercial/industrial category; several metals processing/fabrication facilities; a mine/quarry/mineral processing facility; and a petroleum products manufacturing facility.

WPIN is located in the parking lot of a police station across from George Washington Park, near East 30th Street in northeast Indianapolis. Figure 11-3 shows that the area surrounding WPIN is suburban and residential, with little industry in close proximity. A church and a charitable organization are located across the street from Washington Park, as is Oscar Charleston Park. Figure 11-4 shows that the majority of point sources are located to the south and southwest of WPIN, towards the center of Marion County. The source category with the highest number of sources near WPIN is the airport operations source category. The sources closest to WPIN are a metals processing/fabrication facility and a heliport, each of which is located within 2 miles of WPIN.

In addition to providing city, county, CBSA, and land use/location setting information, Table 11-1 also contains traffic volume information for each site as well as the location for which the traffic volume was obtained. This information is provided because emissions from motor vehicles can significantly affect concentrations measured at a given monitoring site. INDEM experiences a higher traffic volume than WPIN, although the traffic volumes near these sites rank in the middle of the range compared to traffic volumes near other NMP sites. These traffic volumes were obtained for I-90 near 1-65 for INDEM and North Keystone Avenue north of 38th Street for WPIN.

11.2 Pollutants of Interest

The risk-based screening process described in Section 3.2 was performed for each site to identify site-specific "pollutants of interest," which allows analysts and readers to focus on a subset of pollutants through the context of risk. For each site, each pollutant's preprocessed daily measurement was compared to its associated risk screening value. If the concentration was greater than the risk screening value, then the concentration "failed the screen." The site-specific results of this risk-based screening process are presented in Table 11-2 and incorporate measurements from both 2015 and 2016. Pollutants of interest are those for which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens and are shaded in gray in Table 11-2. It is important to note which pollutants were sampled for at each site when reviewing the results of this analysis. Carbonyl compounds were sampled for at both INDEM and WPIN.

Table 11-2. 2015-2016 Risk-Based Screening Results for the Indiana Monitoring Sites

Pollutant	Screening Value (µg/m^3)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Gary, Indiana - INDEM						
Acetaldehyde	0.45	119	119	100.00	50.00	50.00
Formaldehyde	0.077	119	119	100.00	50.00	100.00
Total		238	238	100.00		
Indianapolis, Indiana - WPIN						
Formaldehyde	0.077	116	116	100.00	50.00	50.00
Acetaldehyde	0.45	115	116	99.14	49.57	99.57
Propionaldehyde	0.8	1	116	0.86	0.43	100.00
Total		232	348	66.67		

Observations from Table 11-2 include the following:

- Acetaldehyde, formaldehyde, and propionaldehyde are the carbonyl compounds with risk screening values.
- Acetaldehyde and formaldehyde failed 100 percent of screens for INDEM and contributed equally to the number of failed screens; thus, both pollutants were identified as pollutants of interest for this site.
- Acetaldehyde, formaldehyde, and propionaldehyde each failed screens for WPIN. Formaldehyde failed 100 percent of screens; acetaldehyde failed one less screen than formaldehyde; and propionaldehyde failed a single screen.
- Together, acetaldehyde and formaldehyde account for over 99 percent of failed screens for WPIN, and thus, are the pollutants of interest identified for this site.

For each of the data analyses described in the remaining sections, the focus is on the site-specific pollutants of interest identified via the risk-based screening process, as described in Section 3.4.2.

11.3 Concentrations

This section presents various concentration averages used to characterize air toxics concentration levels at the Indiana monitoring sites. Where applicable, the following calculations and data analyses were performed for each of the site-specific pollutants of interest:

- Time period-based concentration averages (quarterly and annual) are provided for each monitoring site for each year.
- The range of measurements and annual concentration averages are presented graphically for each site to illustrate how the site's concentrations compare to the program-level averages, as presented in Section 4.1.
- Concentration averages and other statistical metrics for 2015, 2016, and from previous years of monitoring are presented in order to characterize concentration trends at each site.

Each data analysis is performed where the applicable criteria are met (as specified in the appropriate sections discussed below) and is limited to the site-specific pollutants of interest. However, site-specific statistical summaries for all pollutants sampled for at the Indiana sites are provided in Appendix M.

11.3.1 2015 and 2016 Concentration Averages

Quarterly and annual concentration averages for 2015 and 2016 were calculated for the pollutants of interest for each Indiana monitoring site, as described in Section 3.1. The *quarterly average concentration* of a particular pollutant is simply the average concentration of the preprocessed daily measurements over a given calendar quarter. Quarterly average concentrations include the substitution of zeros for all non-detects. A site must have a minimum of 75 percent valid samples compared to the total number of samples possible within a given calendar quarter for a quarterly average to be calculated. An *annual average concentration* includes all measured detections and substituted zeros for non-detects for an entire year of sampling. Annual averages were calculated for pollutants where three valid quarterly averages could be calculated for a given year and where method completeness was greater than or equal to 85 percent, as presented in Section 2.4. Quarterly and annual average concentrations for the pollutants of interest for the Indiana monitoring sites are presented in Table 11-3, where applicable. Note that if a pollutant was not detected in a given calendar quarter, the quarterly

average simply reflects "0" because only zeros substituted for non-detects were factored into the quarterly average concentration.

Observations for INDEM from Table 11-3 include the following:

- Acetaldehyde and formaldehyde were detected in all of the valid carbonyl compound samples collected at this site.

- Concentrations of acetaldehyde measured at INDEM varied from 0.509 µg/m^3 to 2.38 µg/m^3, with only a few measurements greater than 2 µg/m^3. Quarterly average concentrations of acetaldehyde range from 0.97 ± 0.13 µg/m^3 (first quarter 2016) to 1.68 ± 0.23 µg/m^3 (third quarter 2015). The annual averages of acetaldehyde for INDEM varied little over the two years of sampling.

- Concentrations of formaldehyde measured at INDEM were higher, and more variable, than the acetaldehyde concentrations. Concentrations of formaldehyde measured at INDEM varied from 1.04 µg/m^3 to 11.0 µg/m^3. The measurements were more variable in 2016 than in 2015, based on the quarterly and annual average concentrations shown in Table 11-3, and their associated confidence intervals. Thirteen of the 14 highest formaldehyde concentrations were measured at this site in 2016. Both the minimum and maximum formaldehyde concentrations measured at INDEM were measured during the third quarter of 2016, as were four of the five formaldehyde concentrations greater than 7 µg/m^3 (with the exception measured at the end of June 2016). This explains the variability shown in the third quarter average for 2016.

Observations for WPIN from Table 11-3 include the following:

- Acetaldehyde and formaldehyde were detected in all of the valid carbonyl compound samples collected at this site.

- Concentrations of acetaldehyde measured at WPIN varied from 0.283 µg/m^3 to 5.60 µg/m^3, with several of the highest concentrations measured during the second quarter of either year. The confidence intervals for both second quarter averages are the highest shown for each year.

- Concentrations of formaldehyde measured at WPIN were higher, and more variable, than the acetaldehyde concentrations measured at this site. Concentrations of formaldehyde measured at WPIN range from 0.806 µg/m^3 to 11.1 µg/m^3, which is similar to the maximum concentration measured at INDEM. For 2015, the first quarter average concentration of formaldehyde is significantly less than the other quarterly averages shown. A review of the data shows that nine of the 10 formaldehyde concentration less than 2 µg/m^3 measured in 2015 were measured in January or February, including all three less than 1 µg/m^3 measured at this site. By comparison, formaldehyde concentration less than 2 µg/m^3 measured in 2016 were split between the first and fourth quarters of the year (with three each).

Table 11-3. Quarterly and Annual Average Concentrations of the Pollutants of Interest for the Indiana Monitoring Sites

Pollutant	2015						2016					
	# of Detects/ # >MDL/ # Samples	Q1 Avg (µg/m^3)	Q2 Avg (µg/m^3)	Q3 Avg (µg/m^3)	Q4 Avg (µg/m^3)	Annual Average (µg/m^3)	# of Detects/ # >MDL/ # Samples	Q1 Avg (µg/m^3)	Q2 Avg (µg/m^3)	Q3 Avg (µg/m^3)	Q4 Avg (µg/m^3)	Annual Average (µg/m^3)
Gary, Indiana - INDEM												
Acetaldehyde	60/60/60	1.24 ± 0.18	1.33 ± 0.21	1.68 ± 0.23	1.17 ± 0.23	1.33 ± 0.12	59/59/59	0.97 ± 0.13	1.41 ± 0.24	1.38 ± 0.24	1.31 ± 0.32	1.26 ± 0.12
Formaldehyde	60/60/60	2.14 ± 0.33	2.93 ± 0.49	4.08 ± 0.68	2.74 ± 0.39	2.95 ± 0.28	59/59/59	2.30 ± 0.32	3.94 ± 1.00	5.62 ± 1.49	2.98 ± 0.57	3.67 ± 0.54
Indianapolis, Indiana - WPIN												
Acetaldehyde	59/59/59	1.53 ± 0.18	1.81 ± 0.53	1.88 ± 0.20	1.59 ± 0.29	1.69 ± 0.15	57/57/57	1.24 ± 0.18	2.14 ± 0.75	1.60 ± 0.40	1.66 ± 0.43	1.64 ± 0.23
Formaldehyde	59/59/59	2.04 ± 0.66	3.98 ± 0.96	4.37 ± 0.78	3.29 ± 0.48	3.36 ± 0.41	57/57/57	2.76 ± 0.37	5.16 ± 1.50	3.65 ± 0.52	3.01 ± 0.66	3.59 ± 0.45

Tables 4-10 through 4-13 present the NMP sites with the 10 highest annual average concentrations for each of the program-level pollutants of interest. Observations for the Indiana sites from those tables include the following:

- Neither INDEM nor WPIN appears in Table 4-11 for their annual average concentrations of acetaldehyde, with annual averages for WPIN ranking greater than 20th and annual averages for INDEM ranking greater than 30th.
- Neither INDEM nor WPIN appears in Table 4-11 for their annual average concentrations of formaldehyde; INDEM and WPIN rank 11th and 12th, respectively, for their 2016 annual averages, with their annual averages for 2015 ranking lower.

11.3.2 Concentration Comparison

In order to better illustrate how each site's annual average concentrations compare to the program-level averages, a site-specific box plot was created for each of the site-specific pollutants of interest, where applicable. Thus, box plots were created for the pollutants listed in Table 11-3 for INDEM and WPIN. Figures 11-5 and 11-6 overlay the sites' minimum, annual average, and maximum concentrations for each year onto the program-level minimum, first quartile, median, average, third quartile, and maximum concentrations, as described in Section 3.4.2.1, and are discussed below. If an annual average concentration could not be calculated, the range of concentrations is still provided in the figures that follow.

Figure 11-5. Program vs. Site-Specific Average Acetaldehyde Concentrations

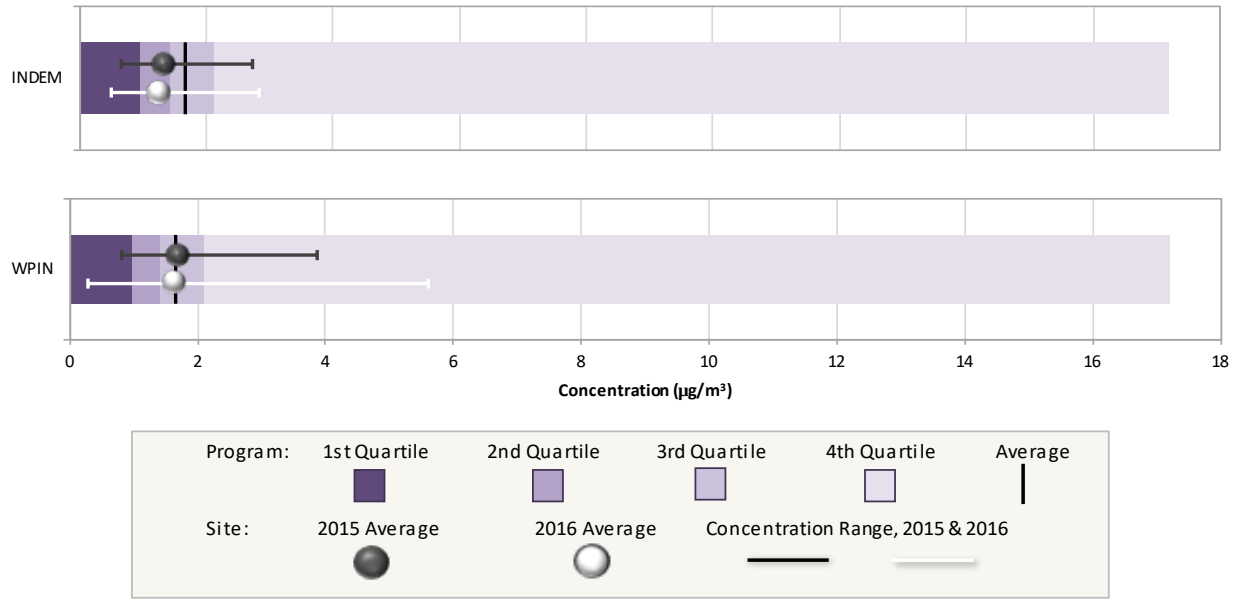


Figure 11-5 presents the box plots for acetaldehyde for both sites and shows the following:

- The range of acetaldehyde concentrations measured at INDEM in 2015 is fairly similar to the range of concentrations measured in 2016. The range of acetaldehyde concentrations measured at WPIN in 2015 is smaller than the range of concentrations measured in 2016. The range of acetaldehyde concentrations measured at INDEM each year is smaller than the range measured at WPIN.

- The annual average concentrations of acetaldehyde calculated for WPIN are similar to each other and to the program-level average concentration of 1.67 µg/m^3. The annual average concentrations of acetaldehyde calculated for INDEM are similar to each other and both are less than the program-level median concentration of 1.43 µg/m^3.

Figure 11-6. Program vs. Site-Specific Average Formaldehyde Concentrations

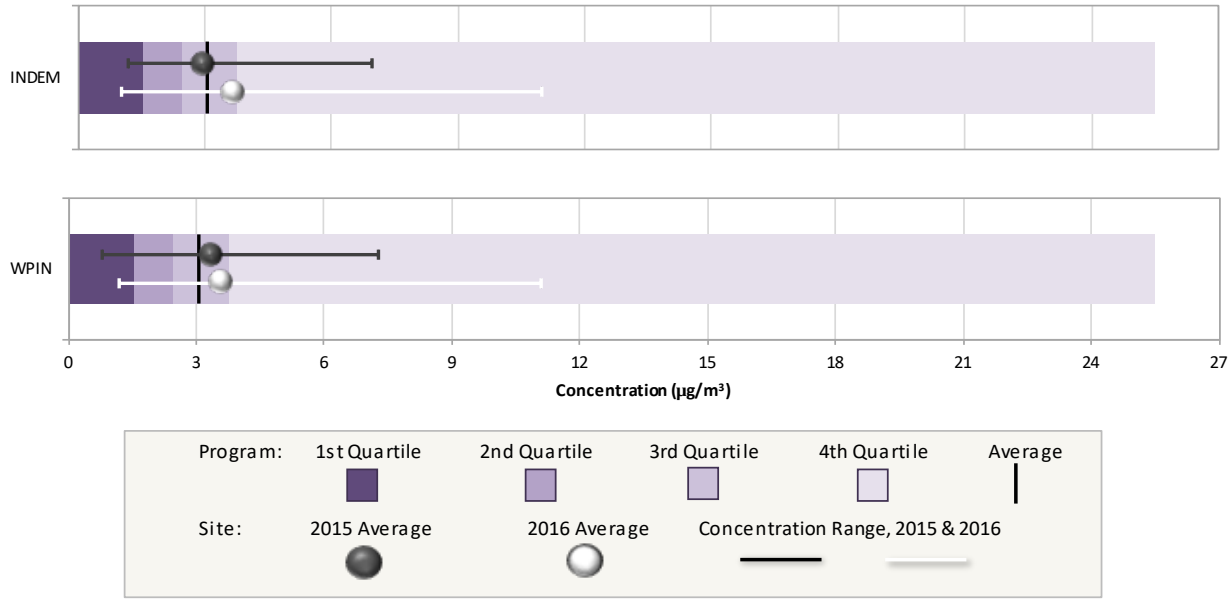


Figure 11-6 presents the box plots for formaldehyde for both sites and shows the following:

- For both INDEM and WPIN, the range of formaldehyde concentrations measured in 2016 is larger than the range of formaldehyde concentrations measured in 2015. The range of concentrations measured each year is similar across the two sites.

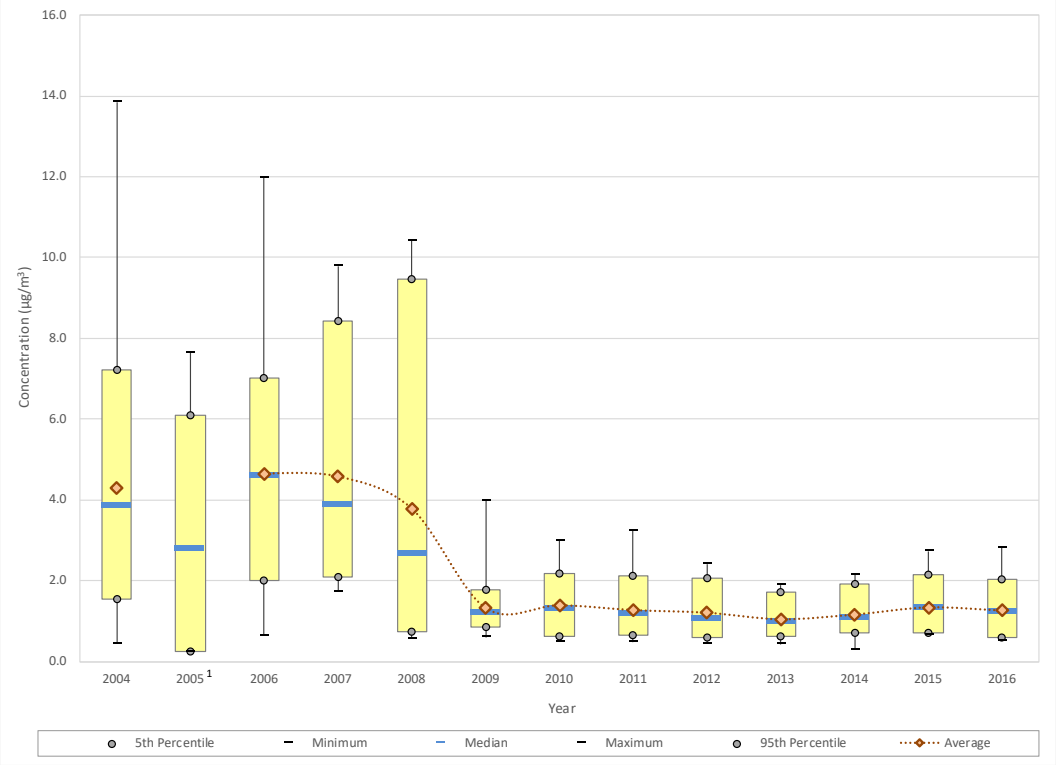
- The annual average concentration for 2015 for INDEM is less than the annual average for 2016; INDEM's annual average concentration for 2015 is just less than the program-level average concentration of 3.05 µg/m^3 while the annual average for 2016 is just less than the program-level third quartile (3.78 µg/m^3).

- The annual average concentrations for WPIN vary less, with both falling between the program-level average concentration and the program-level third quartile.

11.3.3 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the pollutants of interest for 5 consecutive years or longer, as described in Section 3.4.2.2. INDEM and WPIN have sampled carbonyl compounds under the NMP since 2004 and 2007, respectively. Thus, Figures 11-7 through 11-10 present the 1-year statistical metrics for each of the pollutants of interest first for INDEM, then for WPIN. The statistical metrics presented for assessing trends include the substitution of zeros for non-detects. If sampling began mid-year, a minimum of 6 months of sampling is required for inclusion in the trends analysis; in these cases, a 1-year average concentration is not provided, although the range and percentiles are still presented. Note that sampling under the NMP was discontinued at INDEM at the end of 2016.

Figure 11-7. Yearly Statistical Metrics for Acetaldehyde Concentrations Measured at INDEM



[1] A 1-year average is not presented due to a gap in sampling between September and November 2005.

Observations from Figure 11-7 for acetaldehyde concentrations measured at INDEM include the following:

- Although carbonyl compound sampling under the NMP began in 2003, samples were only collected for 3 months. Carbonyl compound sampling began in earnest at INDEM at the beginning of 2004; thus, Figure 11-7 begins with 2004. A 1-year average concentration is not presented for 2005 due to a break in sampling between September and November 2005, although the range of measurements is provided.

- The maximum acetaldehyde concentration shown (13.8 µg/m^3) was measured at INDEM on June 14, 2004. Four additional concentrations greater than 10 µg/m^3 have been measured at INDEM (one in 2006 and three in 2008).

- Although the maximum and 95th percentile increased from 2007 to 2008, the 1-year average, median, 5th percentile, and minimum concentrations of acetaldehyde exhibit decreases from 2007 to 2008. Although three concentrations greater than 10 µg/m^3 were measured in 2008 (compared to zero in 2007), the number of measurements at the lower end of the concentration range increased significantly. The number of acetaldehyde concentrations less than 2 µg/m^3 increased seven-fold (from three in 2007 to 21 in 2008).

- With the exception of the minimum and 5th percentile, the statistical parameters decreased significantly from 2008 to 2009. The 1-year average and median concentrations decreased by more than half and the 95th percentile decreased by more than 80 percent during this time. The carbonyl compound collection system was replaced in 2009, which seems to have had a significant effect on the concentrations measured, particularly with respect to formaldehyde, which is discussed in more detail below.

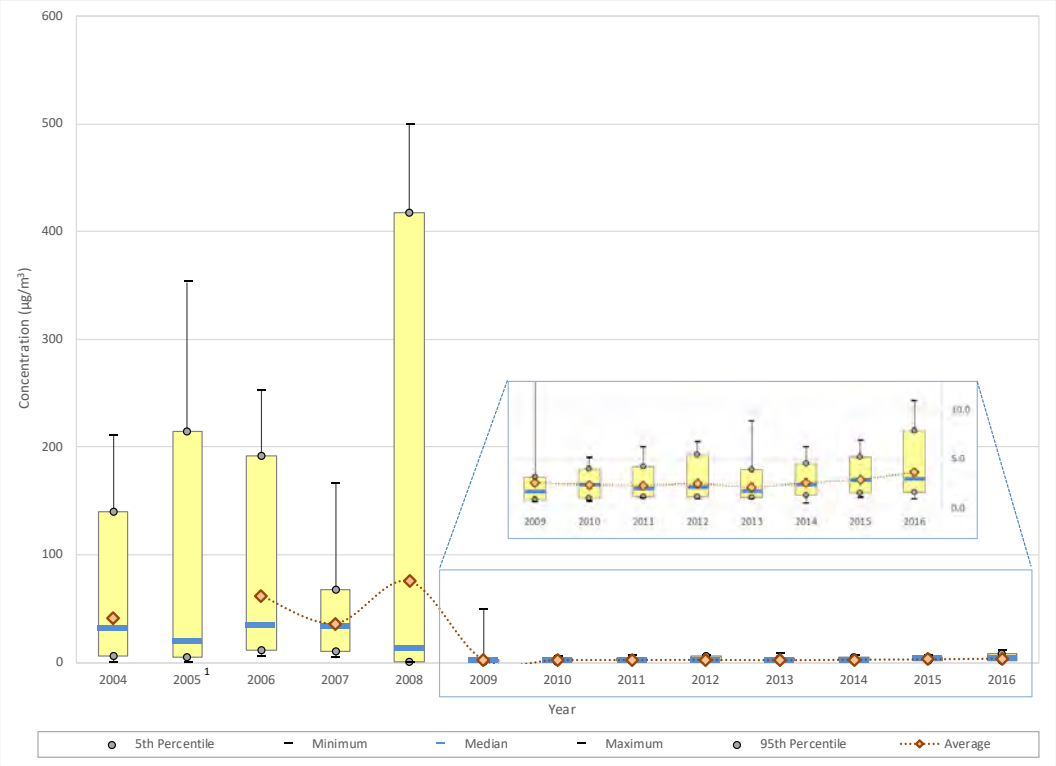
- Acetaldehyde concentrations greater than 4 µg/m^3 were not measured in the years after 2008. After 2008, the year-to-year changes in the statistical parameters for acetaldehyde are smaller in magnitude.

- Most of the statistical parameters exhibit a slight decreasing trend between 2010 and 2013, with many of them at a minimum for 2013. The median concentration for 2013 is less than 1.00 µg/m^3 and the 1-year average concentration is just slightly greater than 1.00 µg/m^3.

- An increasing trend in acetaldehyde concentrations is shown between 2013 and 2015, with the both 1-year average and median concentrations at their highest since 2010 and 2008, respectively.

- With the exception of the maximum concentration, each of the statistical parameters exhibits a slight decrease for 2016.

Figure 11-8. Yearly Statistical Metrics for Formaldehyde Concentrations Measured at INDEM



[1] A 1-year average is not presented due to a break in sampling between September and November 2005.

Observations from Figure 11-8 for formaldehyde concentrations measured at INDEM include the following:

- Five formaldehyde concentrations greater than 400 µg/m^3 were measured in the summer of 2008 (ranging from 414 µg/m^3 to 500 µg/m^3). While these are extremely high values of formaldehyde, concentrations of formaldehyde have been historically high at this site, as shown by the statistics in Figure 11-8. Thirty-eight concentrations of formaldehyde greater than 100 µg/m^3 have been measured at INDEM.

- Prior to 2009, the maximum concentration for each year is greater than 150 µg/m^3. The median concentrations for 2004, 2006, and 2007 are greater than 30 µg/m^3, indicating that at least half of the concentrations were greater than 30 µg/m^3 for these years; the median concentration for 2005 and 2008 are both greater than 10 µg/m^3.

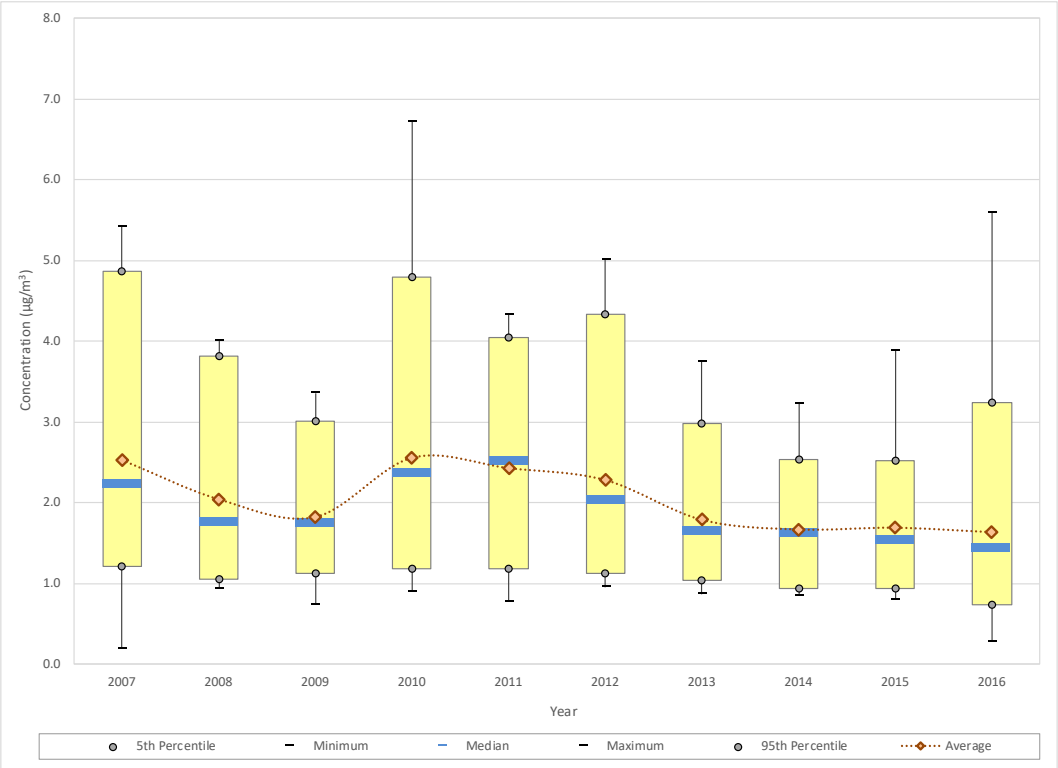
- Although the 1-year average concentration doubled from 2007 to 2008, the median concentration decreased by more than half. This means that although the magnitude of those higher measurements is driving the 1-year average concentration upward, there were also a larger number of concentrations at the lower end of the concentration range. Twenty-four formaldehyde concentrations measured in 2008 were less than the minimum concentration measured in 2007; those 24 measurements represent 41 percent of the concentrations measured in 2008. The last "high" formaldehyde concentration was measured on August 4, 2008, after which formaldehyde concentrations greater than 4 µg/m^3 were not measured that year.

- All the statistical metrics decreased significantly for 2009. Between 2009 and 2013, less than 0.5 µg/m^3 separates the 1-year average concentrations, ranging from 2.13 µg/m^3 (2013) to 2.58 µg/m^3 (2014). The number of formaldehyde measurements greater than 4 µg/m^3 ranged from two to seven for each year during this time, compared to accounting for more than half of the measurements in each of the previous years.

- INDEM's formaldehyde concentrations have historically been higher than any other NMP site sampling carbonyl compounds. During the summer PAMS season, which begins on June 1, a state-owned multi-channel collection system was used at INDEM to collect multiple samples per day. At the end of each PAMS season, sample collection goes back to a state-owned single-channel collection system. The multi-channel collection system used at INDEM during the PAMS season was replaced in 2009 and this site's formaldehyde concentrations decreased substantially (as did their acetaldehyde concentrations, but the difference is less dramatic). Given that the elevated concentrations of formaldehyde were typically measured during the summer, this change could account for the differences in the concentrations measured before and after 2009. Thus, the elevated concentrations from previous years were likely related to the multi-channel collection equipment and may not reflect the actual levels in ambient air. However, concentrations in the earlier years of sampling must have still been higher based on the median concentrations shown before and after 2009, as discussed in the previous bullets.

- Both the 1-year average and median concentrations of formaldehyde have an increasing trend between 2013 and 2016, with the 1-year average concentration increasing by more than 1.5 µg/m^3 during this period. For 2016, both of these central tendency parameters are at their highest since the replacement of the collection system in 2009. 2016 is the first year that a formaldehyde concentration greater than 10 µg/m^3 has been measured since 2009; the number of formaldehyde measurements greater than 4 µg/m^3 increased from three in 2013 to nine for 2014 and 2015, to 16 for 2016.

Figure 11-9. Yearly Statistical Metrics for Acetaldehyde Concentrations Measured at WPIN



Observations from Figure 11-9 for acetaldehyde concentrations measured at WPIN include the following:

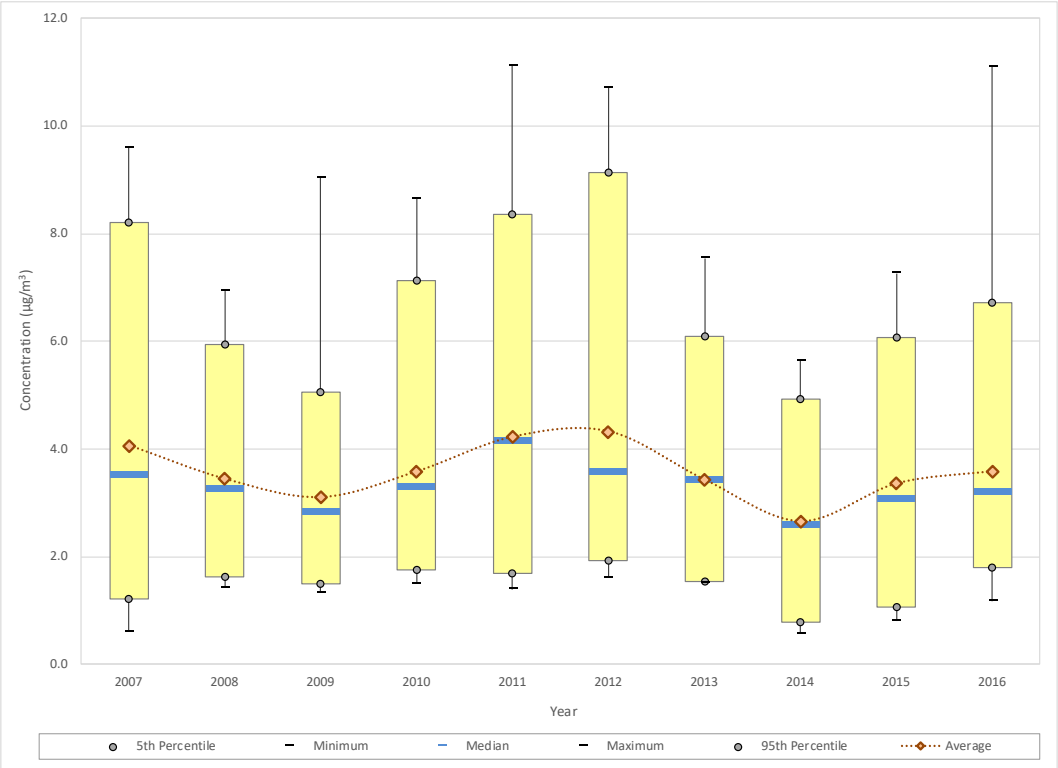
- Although carbonyl compound sampling under the NMP began in 2006, samples were collected intermittently. Carbonyl compound sampling began in earnest at WPIN at the beginning of 2007; thus, Figure 11-9 begins with 2007.

- The three highest acetaldehyde concentrations were measured at WPIN in 2010 and ranged from 5.96 µg/m^3 to 6.72 µg/m^3. Four additional concentrations greater than 5 µg/m^3 have been measured at WPIN (two in 2007, one in 2012, and one in 2016).

- The 1-year average concentration has a decreasing trend through 2009, after which a significant increase is shown for 2010. All of the statistical parameters exhibit an increase for 2010, particularly the maximum concentration (which doubled) and the 95th percentile (which increased by nearly 60 percent). The number of acetaldehyde concentrations greater than 3 µg/m^3 increased five-fold, from three measured in 2009 to 15 measured in 2010. This increase returns the statistical parameters for 2010 to near 2007 levels.

- Acetaldehyde concentrations measured at WPIN have a decreasing trend after 2010 and, despite a larger range of concentrations measured in 2016, both the 1-year average and median concentrations are at a minimum for 2016. The rate of decrease slowed considerably in recent years.

Figure 11-10. Yearly Statistical Metrics for Formaldehyde Concentrations Measured at WPIN



Observations from Figure 11-10 for formaldehyde concentrations measured at WPIN include the following:

- The maximum concentration of formaldehyde measured at WPIN (11.1 µg/m^3) has been measured twice, once in 2011 and once in 2016. Two additional formaldehyde concentrations greater than 10 µg/m^3 were measured in 2012.

- The 1-year average concentration has a decreasing trend through 2009, similar to acetaldehyde, after which an increasing trend is shown through 2012. Although the 1-year average concentration did not change significantly between 2011 and 2012, the median concentration for 2012 decreased considerably. While the range of concentrations did not change much between the two years, the biggest change between the two datasets is in the number of concentrations in the middle of the concentration range; the number of formaldehyde measurements between 3 µg/m^3 and 4 µg/m^3 more than doubled, from seven in 2011 to 15 in 2012.

- A decreasing trend in formaldehyde concentrations is shown between 2012 and 2014, with all of the statistical parameters exhibiting decreases during this period. Further, each statistical parameter is at a minimum for 2014, with the 1-year average concentration less than 3 µg/m^3 for the first time.

- This decreasing trend is followed by an increasing trend for 2015 and 2016.

11.4 Additional Risk-Based Screening Evaluations

The following risk-based screening evaluations were conducted to characterize risk related to the air toxics measured at each Indiana monitoring site. Refer to Sections 3.2, 3.4.2.3, and 3.4.2.4 for definitions and explanations regarding the various toxicity factors, time frames, and calculations associated with these risk-based screenings.

11.4.1 Cancer Risk and Noncancer Hazard Approximations

For the pollutants of interest for the Indiana sites, risk was examined by calculating cancer risk and noncancer hazard approximations for each year annual average concentrations could be calculated. These approximations can be used as risk estimates for cancer and noncancer effects attributable to the pollutants of interest. Although the use of these approximations is limited, they may help identify where policy-makers want to shift their air monitoring priorities. Refer to Section 3.4.2.3 for an explanation of how cancer risk and noncancer hazard approximations are calculated and what limitations are associated with them. Annual averages, cancer UREs and/or noncancer RfCs, and cancer risk and noncancer hazard approximations are presented in Table 11-4, where applicable. Cancer risk approximations are presented as probabilities while the noncancer hazard approximations are ratios and thus, unitless values.

Observations for the Indiana sites from Table 11-4 include the following:

- For both sites, the annual average concentrations of formaldehyde are greater than the annual average concentrations of acetaldehyde. The annual average concentrations of acetaldehyde for WPIN are greater than the annual averages of acetaldehyde for INDEM. For formaldehyde, this is true for 2015 but not 2016.

- The cancer risk approximations for formaldehyde are an order of magnitude higher than the cancer risk approximations for acetaldehyde for both sites. The cancer risk approximations for formaldehyde for INDEM are 38.34 in-a-million for 2015 and 47.66 in-a-million for 2016, with the cancer risk approximations for WPIN falling in-between. Cancer risk approximations for acetaldehyde range from 2.77 in-a-million (INDEM, 2016) to 3.72 in-a-million (WPIN, 2015).

- Neither pollutant of interest for INDEM or WPIN has a noncancer hazard approximation greater than 1.0, indicating that no adverse noncancer health effects are expected from these individual pollutants. The highest noncancer hazard approximation was 0.37, which was calculated for both sites, based on the 2016 annual average concentrations of formaldehyde.

Table 11-4. Risk Approximations for the Indiana Monitoring Sites

Pollutant	Cancer URE ($\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	2015				2016			
			# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Risk Approximations		# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Risk Approximations	
					Cancer (in-a-million)	Noncancer (HQ)			Cancer (in-a-million)	Noncancer (HQ)
Gary, Indiana - INDEM										
Acetaldehyde	0.0000022	0.009	60/60	1.33 ± 0.12	2.94	0.15	59/59	1.26 ± 0.12	2.77	0.14
Formaldehyde	0.000013	0.0098	60/60	2.95 ± 0.28	38.34	0.30	59/59	3.67 ± 0.54	47.66	0.37
Indianapolis, Indiana - WPIN										
Acetaldehyde	0.0000022	0.009	59/59	1.69 ± 0.15	3.72	0.19	57/57	1.64 ± 0.23	3.60	0.18
Formaldehyde	0.000013	0.0098	59/59	3.36 ± 0.41	43.65	0.34	57/57	3.59 ± 0.45	46.61	0.37

11.4.2 Risk-Based Emissions Assessment

In addition to the risk-based screening discussed above, this section presents an evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 11-5 presents the 10 pollutants with the highest emissions from the 2014 NEI (version 1) that have cancer toxicity factors. Table 11-5 also presents the 10 pollutants with the highest toxicity-weighted emissions, based on the weighting schema described in Section 3.4.2.4. Lastly, Table 11-5 provides the pollutants with the highest cancer risk approximations (in-a-million) for each site, as presented in Table 11-4. Cancer risk approximations for 2015 are presented in green while approximations for 2016 are in white. The emissions, toxicity-weighted emissions, and cancer risk approximations are shown in descending order in Table 11-5. Table 11-6 presents similar information, but is limited to those pollutants with noncancer toxicity factors.

Because not all pollutants have both cancer and noncancer toxicity factors, the highest emitted pollutants in the cancer table may be different from the noncancer table, although the actual quantity of emissions is the same. The cancer risk and noncancer hazard approximations based on each site's annual averages are limited to the pollutants of interest identified for each site. In addition, the cancer risk and noncancer hazard approximations are limited to those pollutants with enough data to meet the criteria for annual averages to be calculated. A more in-depth discussion of this analysis is provided in Section 3.4.2.4. Similar to the cancer risk and noncancer hazard approximations provided in Section 11.4.1, this analysis may help policy-makers prioritize their air monitoring activities.

Table 11-5. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Indiana Monitoring Sites

Top 10 Total Emissions for Pollutants with Cancer UREs (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Gary, Indiana (Lake County) - INDEM					
Benzene	194.05	Formaldehyde	2.10E-03	Formaldehyde	47.66
Formaldehyde	161.83	Benzene	1.51E-03	Formaldehyde	38.34
Ethylbenzene	97.22	Naphthalene	1.28E-03	Acetaldehyde	2.94
Acetaldehyde	96.21	Coke Oven Emissions, PM	1.19E-03	Acetaldehyde	2.77
Naphthalene	37.50	1,3-Butadiene	8.90E-04		
1,3-Butadiene	29.66	POM, Group 1b	7.65E-04		
Bis(2-ethylhexyl) phthalate, gas	22.83	POM, Group 2b	3.42E-04		
POM, Group 1b	8.70	Cadmium, PM	3.38E-04		
POM, Group 2b	3.88	POM, Group 2d	3.12E-04		
POM, Group 2d	3.55	Arsenic, PM	3.08E-04		
Indianapolis, Indiana (Marion County) - WPIN					
Benzene	349.62	Formaldehyde	4.01E-03	Formaldehyde	46.61
Formaldehyde	308.77	Benzene	2.73E-03	Formaldehyde	43.65
Ethylbenzene	202.77	Naphthalene	1.80E-03	Acetaldehyde	3.72
Acetaldehyde	197.48	1,3-Butadiene	1.54E-03	Acetaldehyde	3.60
Naphthalene	52.95	Arsenic, PM	9.98E-04		
1,3-Butadiene	51.37	POM, Group 2b	5.72E-04		
Bis(2-ethylhexyl) phthalate, gas	43.23	Ethylbenzene	5.07E-04		
Tetrachloroethylene	14.44	POM, Group 2d	4.53E-04		
POM, Group 2b	6.50	Acetaldehyde	4.34E-04		
POM, Group 2d	5.15	POM, Group 5a	4.01E-04		

[1] Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Table 11-6. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the Indiana Monitoring Sites

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific) [1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Hazard Approximation (HQ)**
Gary, Indiana (Lake County) - INDEM					
Toluene	610.91	Acrolein	537,322.19	Formaldehyde	0.37
Xylenes	360.37	Manganese, PM	58,805.75	Formaldehyde	0.30
Hydrochloric acid	256.95	Lead, PM	38,552.81	Acetaldehyde	0.15
Hexane	246.81	2,4-Toluene diisocyanate	27,925.71	Acetaldehyde	0.14
Methanol	224.95	Cadmium, PM	18,793.80		
Benzene	194.05	Formaldehyde	16,512.88		
Formaldehyde	161.83	1,3-Butadiene	14,828.51		
Ethylbenzene	97.22	Hydrochloric acid	12,847.50		
Acetaldehyde	96.21	Naphthalene	12,501.56		
Naphthalene	37.50	Acetaldehyde	10,689.83		
Indianapolis, Indiana (Marion County) - WPIN					
Toluene	1,444.06	Acrolein	1,191,081.87	Formaldehyde	0.37
Xylenes	761.49	2,4-Toluene diisocyanate	52,756.71	Formaldehyde	0.34
Hydrochloric acid	543.66	Formaldehyde	31,506.82	Acetaldehyde	0.19
Methanol	531.90	Hydrochloric acid	27,182.77	Acetaldehyde	0.18
Benzene	349.62	1,3-Butadiene	25,684.69		
Formaldehyde	308.77	Acetaldehyde	21,941.93		
Hexane	299.13	Lead, PM	18,973.21		
Ethylbenzene	202.77	Naphthalene	17,651.26		
Acetaldehyde	197.48	Arsenic, PM	15,480.43		
Ethylene glycol	78.78	Benzene	11,653.89		

[1] Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Observations from Table 11-5 include the following:

- Benzene, formaldehyde, and ethylbenzene are the three highest emitted pollutants with cancer UREs in both Marion and Lake Counties, although the quantity emitted is higher in Marion County. Nine of the 10 pollutants listed are the same between the two counties; the only difference is the eighth ranked pollutant for each county, POM Group 1 (for Lake County) and tetrachloroethylene (for Marion County).

- Formaldehyde, benzene, and naphthalene are the pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) for both counties.

- Seven of the highest emitted pollutants in Lake County also have the highest toxicity-weighted emissions; eight of the highest emitted pollutants in Marion County also have the highest toxicity-weighted emissions.

- Acetaldehyde and formaldehyde are the only pollutants of interest for INDEM. Acetaldehyde and formaldehyde appear among the highest emitted pollutants for Lake County, with only formaldehyde appearing among the pollutants with the highest toxicity-weighted emissions (acetaldehyde ranks 14th). Formaldehyde has the highest toxicity-weighted emissions in Lake County.

- Acetaldehyde and formaldehyde are also the pollutants of interest for WPIN. Acetaldehyde and formaldehyde appear among the highest emitted pollutants for Marion County, and are both among the pollutants with the highest toxicity-weighted emissions. Formaldehyde also has the highest toxicity-weighted emissions in Marion County.

Observations from Table 11-6 include the following:

- Toluene, xylenes, and hydrochloric acid are the three highest emitted pollutants with noncancer RfCs in both Marion and Lake Counties, although the quantity emitted is higher in Marion County. Nine of the 10 pollutants listed are the same between the two counties; the only difference is the tenth ranked pollutant for each county, naphthalene (for Lake County) and ethylene glycol (for Marion County).

- Acrolein is the pollutant with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) for both counties. Manganese and lead rank second and third for Lake County, while 2,4-toluene diisocyanate and formaldehyde rank second and third for Marion County.

- Four of the highest emitted pollutants in Lake County also have the highest toxicity-weighted emissions. This is also true for Marion County, although the pollutants are somewhat different.

- Formaldehyde and acetaldehyde appear in all three columns in Table 11-6 for both sites.

11.5 Summary of the 2015-2016 Monitoring Data for INDEM and WPIN

Results from several of the data analyses described in this section include the following:

- *Carbonyl compounds were sampled for at INDEM and WPIN in 2015 and 2016. Sampling at INDEM under the NMP was discontinued at the end of 2016, ending a 13-year continuous monitoring effort.*

- *Acetaldehyde and formaldehyde failed screens for each site and were identified as pollutants of interest for each site.*

- *The annual average concentrations of formaldehyde are greater than the annual average concentrations of acetaldehyde for both sites.*

- *Concentrations of formaldehyde and acetaldehyde decreased significantly at INDEM from 2008 to 2009; these changes may be at least partially explained by the replacement of the collection system. Although considerably less than those measured before 2009, concentrations of formaldehyde have a slight increasing trend at INDEM over the last few years; this is also true for acetaldehyde through 2015.*

- *Acetaldehyde concentrations have been decreasing at WPIN since 2010, although the rate of decrease slowed considerably in recent years. After a few years of decreasing, formaldehyde concentrations have an increasing trend at WPIN in 2015 and 2016.*

- *Formaldehyde has the highest cancer risk approximations among the pollutants of interest for both sites; none of the pollutants of interest for either site have noncancer hazard approximations greater than an HQ of 1.0.*

12.0 Sites in Kentucky

This section summarizes those data from samples collected at the NATTS and UATMP sites in Kentucky and generated by ERG, EPA's contract laboratory for the NMP, over the 2015 and 2016 monitoring efforts. This section also examines the spatial and temporal characteristics of the ambient monitoring concentrations and reviews them through the context of risk. Readers are encouraged to refer to Sections 1 through 4 for detailed discussions and definitions regarding the various data analyses presented below.

> Data generated by sources other than ERG, EPA's contract laboratory for the NMP, are not included in the data analyses contained in this report.

12.1 Site Characterization

This section characterizes the Kentucky monitoring sites by providing a description of the nearby area surrounding each monitoring site; plotting emissions sources surrounding the monitoring sites; and presenting traffic data and other characterizing information for each site. This information is provided to give the reader insight regarding factors that may influence the air quality near the sites and assist in the interpretation of the ambient measurements.

Data from eight monitoring sites in Kentucky are included in this report, one NATTS site and seven predominantly "source-oriented" sites: three sites are located in northeast Kentucky, two in Ashland and one near Grayson Lake; one is located south of Evansville, Indiana in the town of Baskett; three are located in or near the Calvert City area, east of Paducah, Kentucky; and the final site is located in Lexington, in north-central Kentucky. A composite satellite image and a facility map are provided for each site in Figures 12-1 through 12-13. The composite satellite images were retrieved from ArcGIS Explorer and show each monitoring site in its respective location. The facility maps identify nearby point source emissions locations by source category, as reported in the 2014 NEI for point sources, version 1. Note that only sources within 10 miles of each site are included in the facility counts provided. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have a direct effect on the air quality at each monitoring site. Further, this boundary provides both the proximity of emissions sources to each monitoring site as well as the quantity of such sources within a given distance of the sites. Sources outside the 10-mile boundaries are still visible on the maps for reference but have been grayed out to emphasize emissions sources within the boundaries. Table 12-1 provides supplemental geographical information such as land use, location setting, and locational coordinates for each site. Each figure and table is discussed in detail in the paragraphs that follow.

Figure 12-1. Ashland, Kentucky (ASKY) Monitoring Site

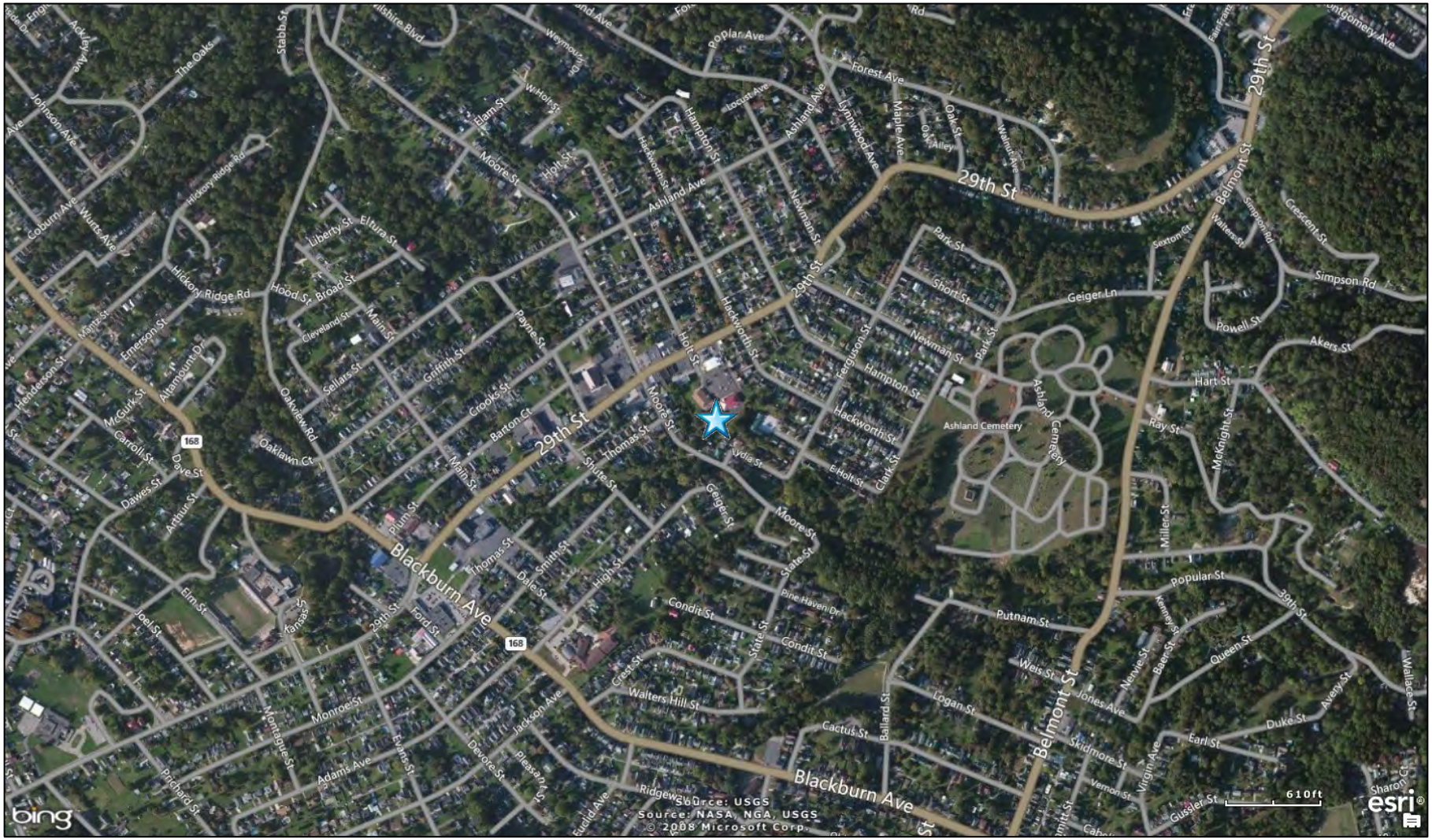


Figure 12-2. Ashland, Kentucky (ASKY-M) Monitoring Site

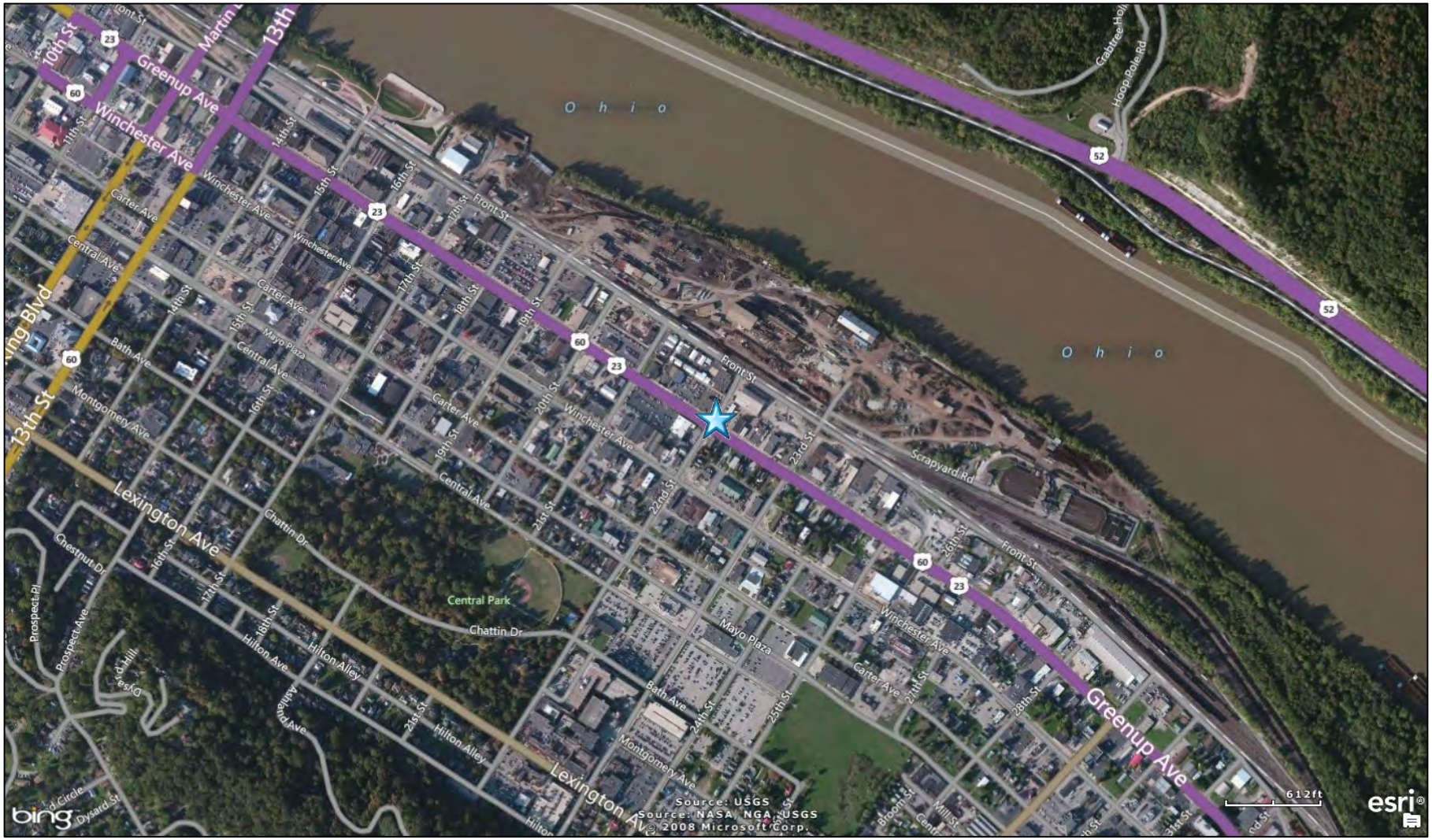


Figure 12-3. NEI Point Sources Located Within 10 Miles of ASKY and ASKY-M

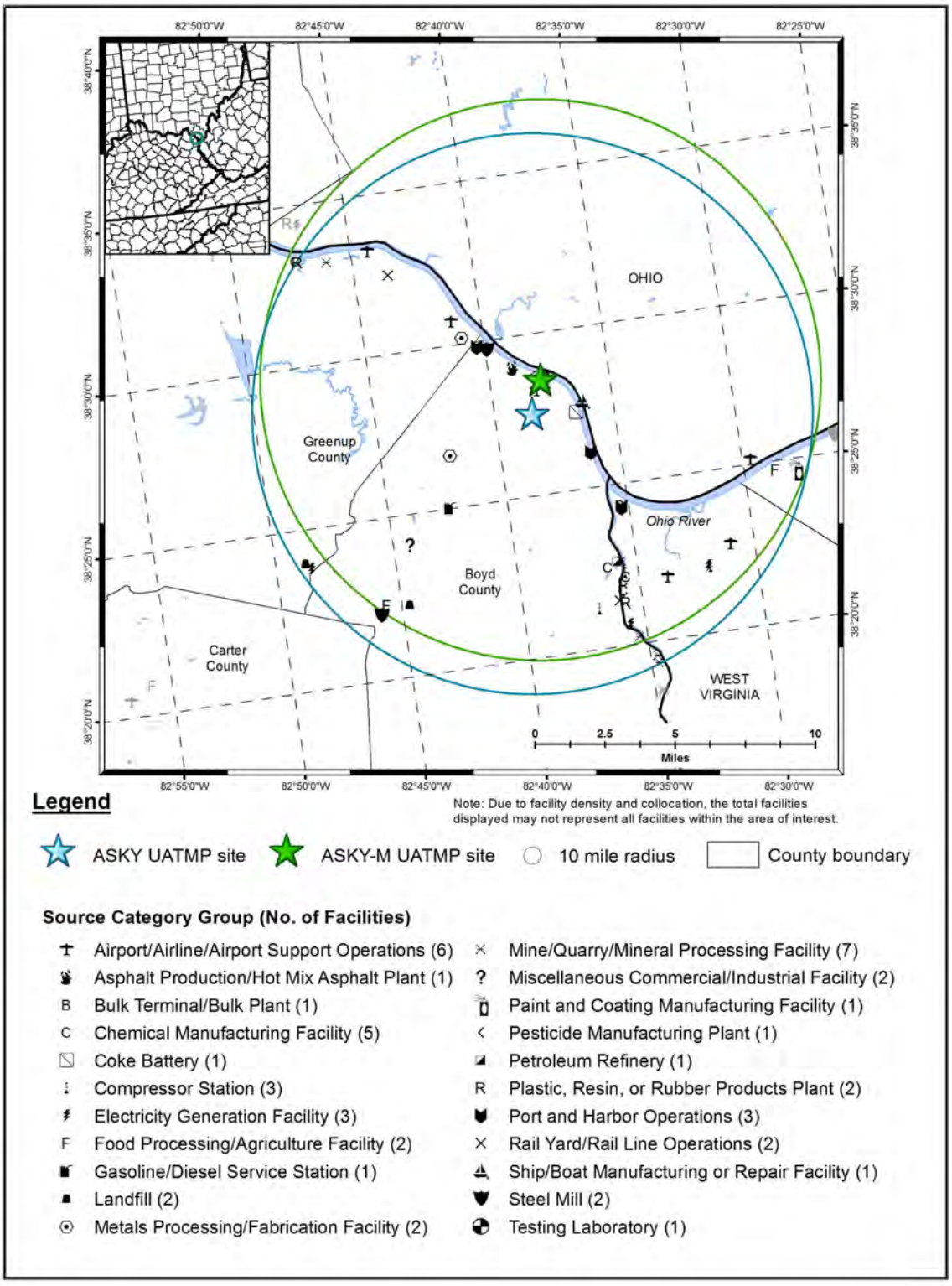


Figure 12-4. Grayson, Kentucky (GLKY) Monitoring Site

Figure 12-5. NEI Point Sources Located Within 10 Miles of GLKY

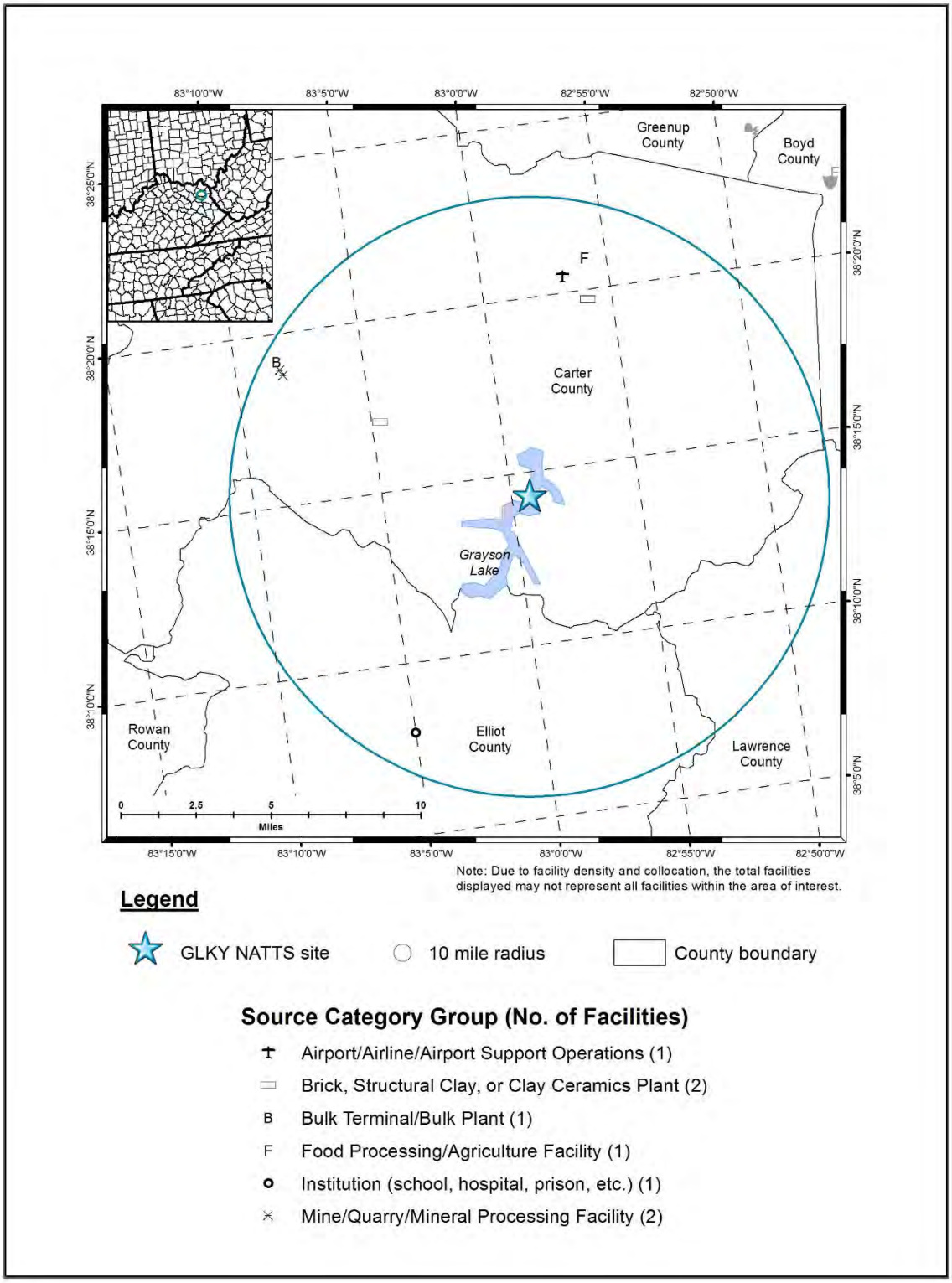


Figure 12-6. Baskett, Kentucky (BAKY) Monitoring Site

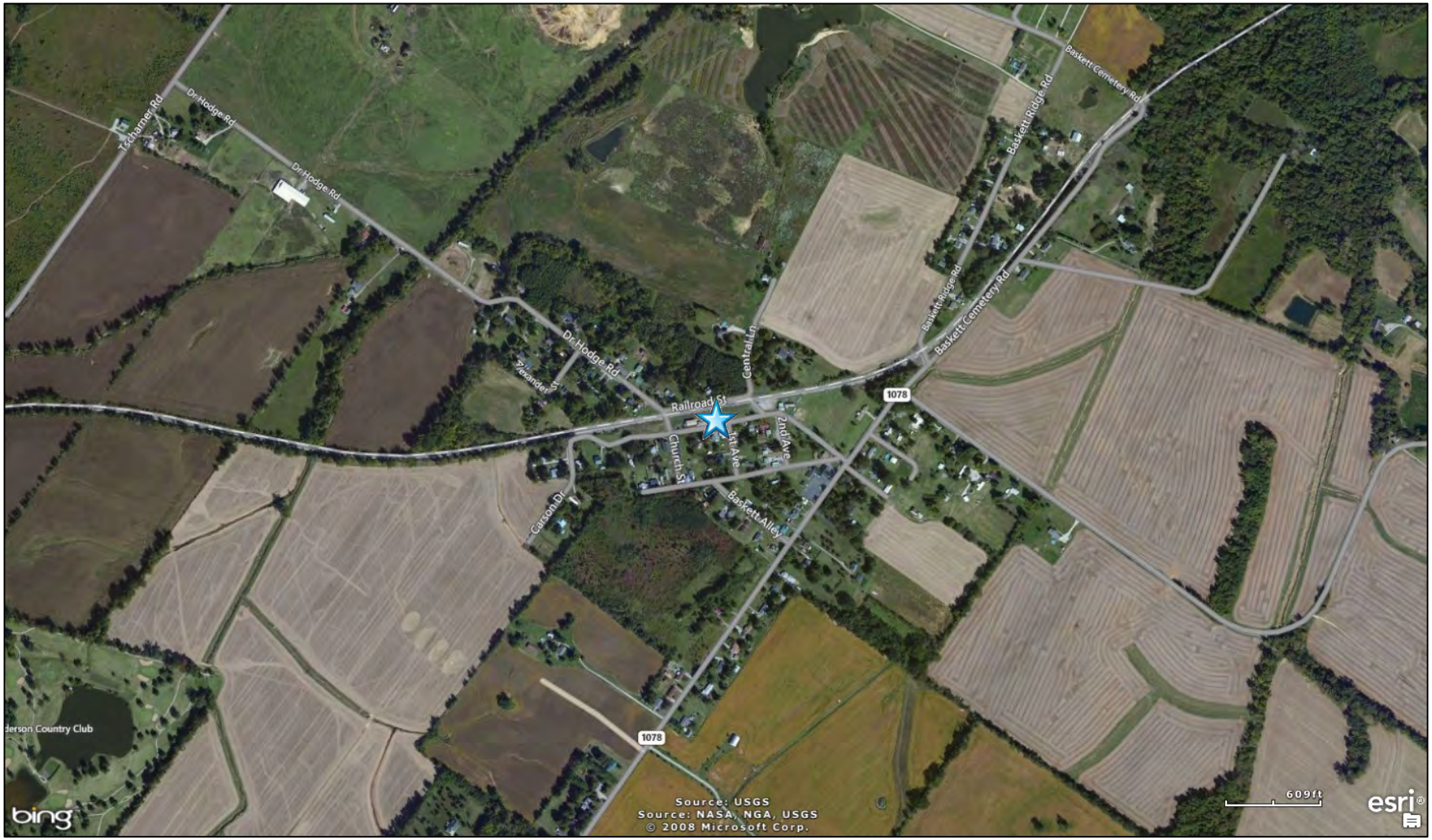


Figure 12-7. NEI Point Sources Located Within 10 Miles of BAKY

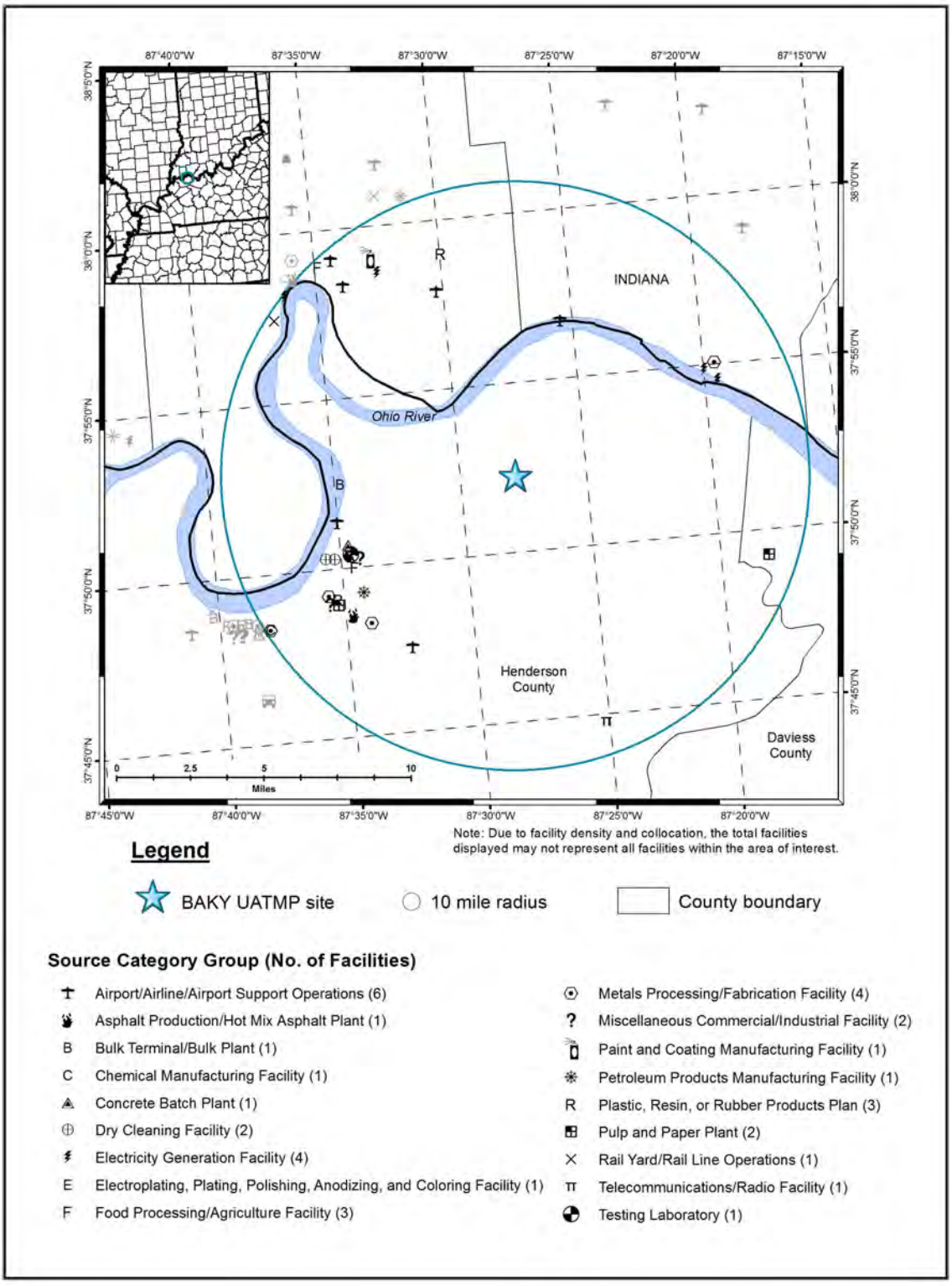


Figure 12-8. Calvert City, Kentucky (ATKY) Monitoring Site

Figure 12-9. Smithland, Kentucky (BLKY) Monitoring Site

Figure 12-10. Calvert City, Kentucky (TVKY) Monitoring Site

Figure 12-11. NEI Point Sources Located Within 10 Miles of ATKY, BLKY, and TVKY

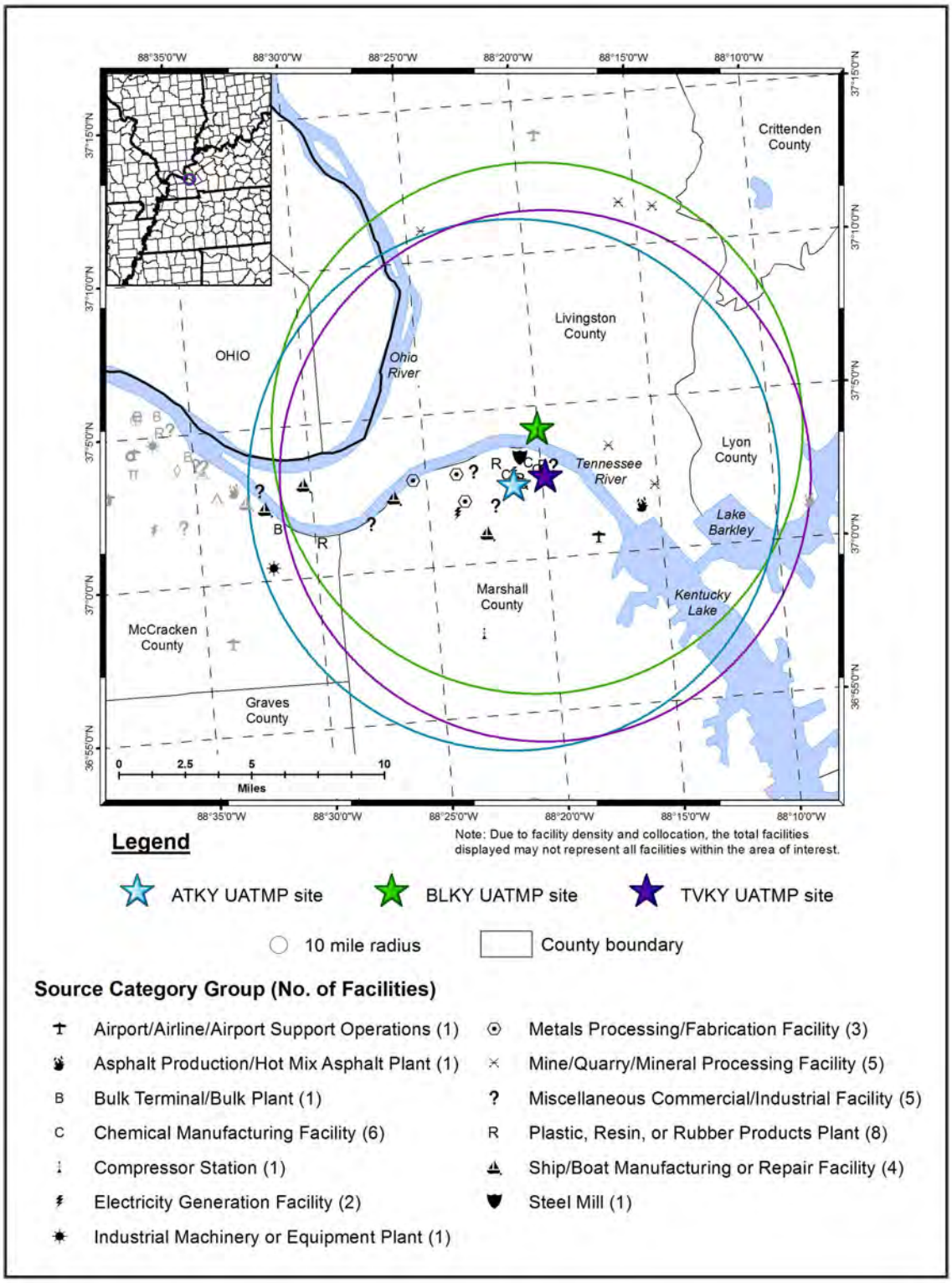


Figure 12-12. Lexington, Kentucky (LEKY) Monitoring Site

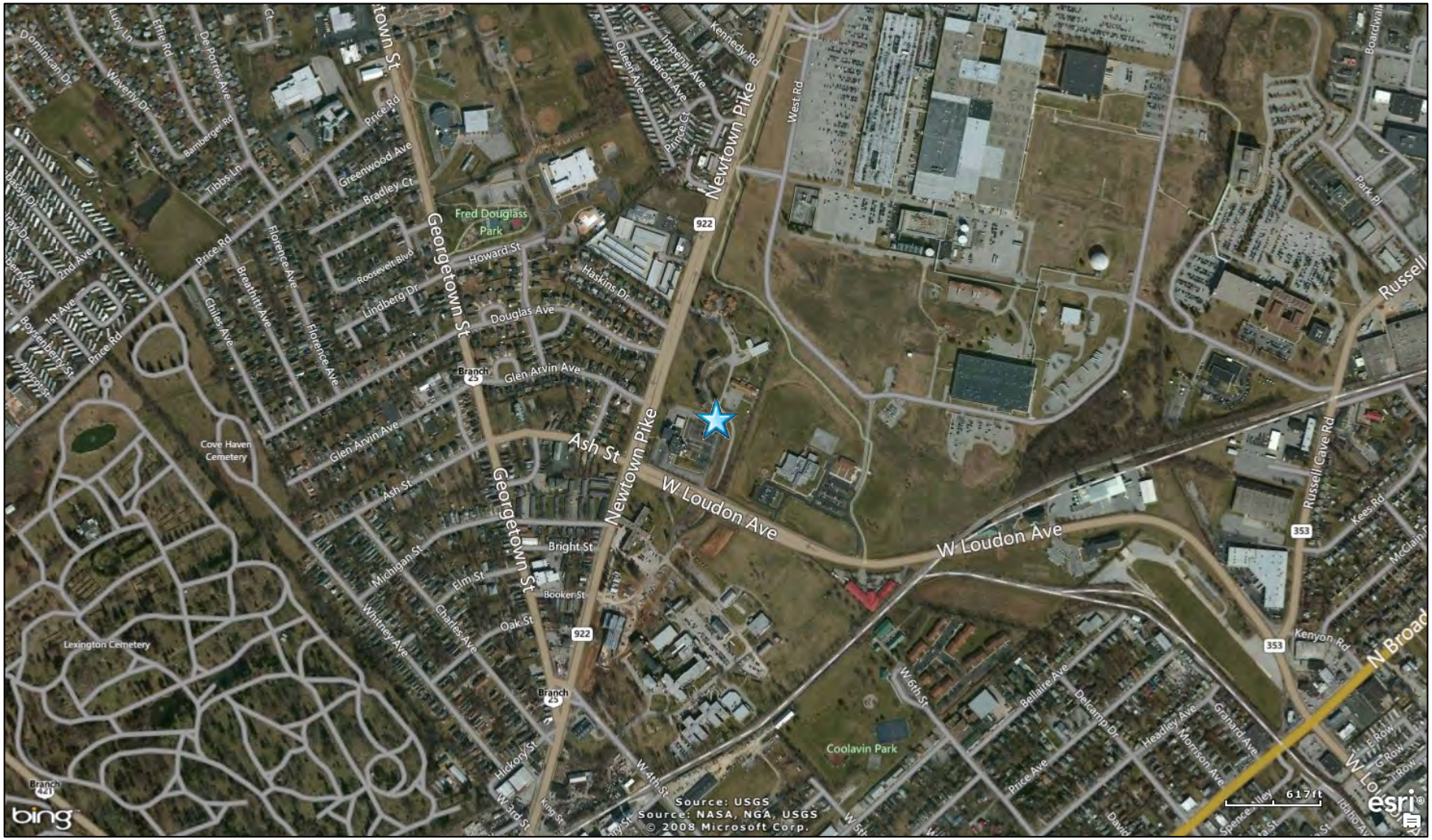


Figure 12-13. NEI Point Sources Located Within 10 Miles of LEKY

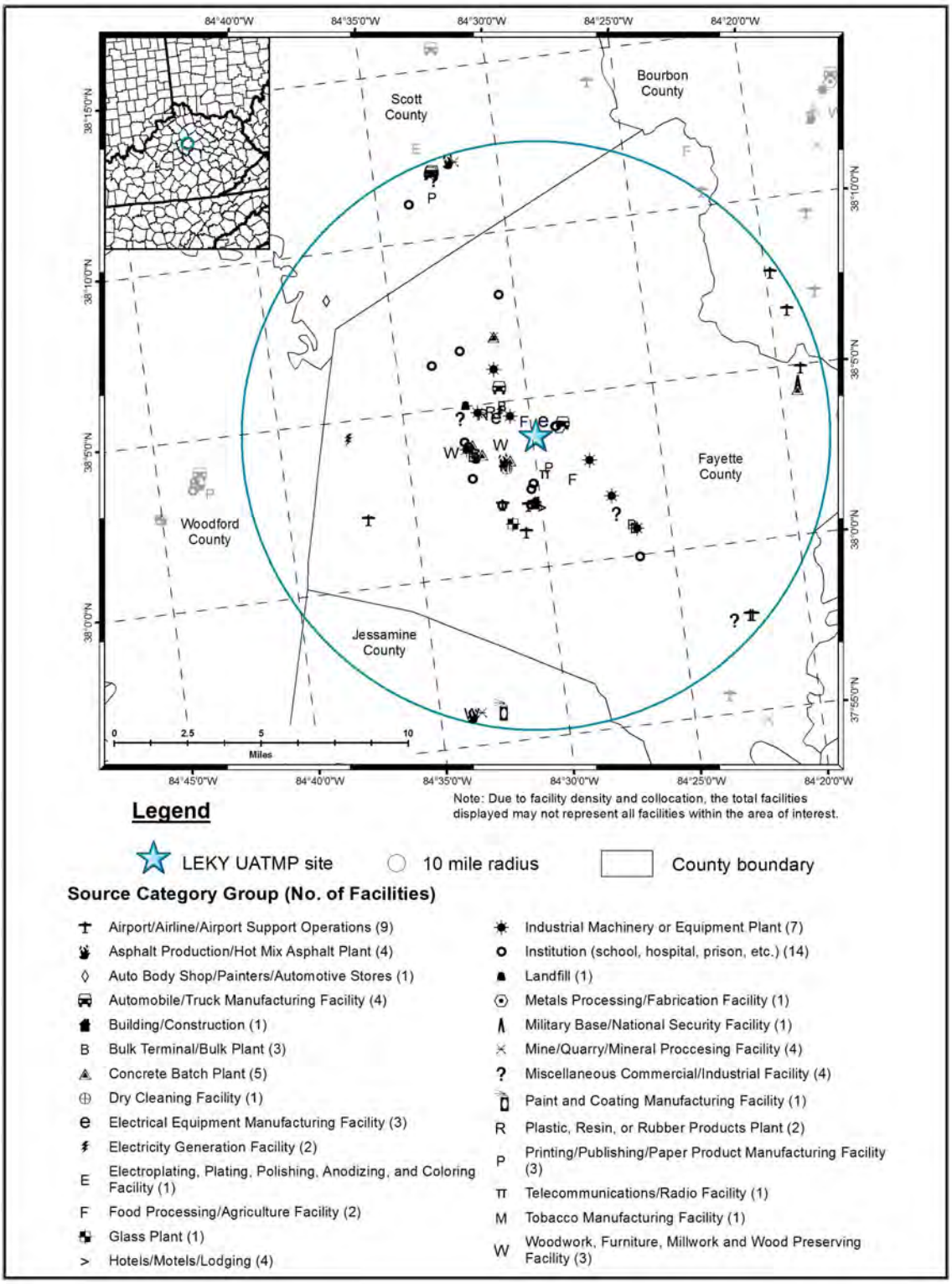


Table 12-1. Geographical Information for the Kentucky Monitoring Sites

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Annual Average Daily Traffic[1]	Intersection Used for Traffic Data
ASKY	21-019-0017	Ashland	Boyd	Huntington-Ashland, WV-KY-OH	38.459340, -82.640410	Residential	Suburban	5,934	29th St between Newman St and Lynwood Ave
ASKY-M	21-019-0002	Ashland	Boyd	Huntington-Ashland, WV-KY-OH	38.476000, -82.631370	Industrial	Urban/City Center	13,241	Greenup (23rd) between 16th St and 17th St
GLKY	21-043-0500	Grayson	Carter	None	38.238870, -82.988100	Residential	Rural	303	Rd 1496, S of Camp Webb Rd
BAKY	21-101-0014	Baskett	Henderson	Evansville, IN-KY	37.871200, -87.463750	Commercial	Rural	929	Rte 1078, N of Hwy 60
ATKY	21-157-0016	Calvert City	Marshall	None	37.041760, -88.354070	Industrial	Suburban	3,672	Main St (Rte 95), S of Johnson Riley Rd
BLKY	21-139-0004	Smithland	Livingston	Paducah, KY-IL	37.071510, -88.333890	Agricultural	Rural	2,011	Rte 93/453, E of Bloodworth Rd
TVKY	21-157-0014	Calvert City	Marshall	None	37.045200, -88.330870	Industrial	Suburban	1,458	Industrial Pkwy (Rte 1523), E of Plant Cut-off Rd
LEKY	21-067-0012	Lexington	Fayette	Lexington-Fayette, KY	38.065030, -84.497610	Residential	Suburban	18,993	Newton Pike, N of W Loudon Ave

[1]AADT reflects 2012 data for GLKY; 2014 data for ASKY, LEKY & TVKY; 2015 data for ASKY-M, ATKY, and BAKY; and 2016 data for BLKY (KYTC, 2016)
BOLD ITALICS = EPA-designated NATTS Site

Two Kentucky monitoring sites are located in the town of Ashland. Ashland is located on the Ohio River, just north of where the borders of Kentucky, West Virginia, and Ohio meet, and is part of the Huntington-Ashland, WV-KY-OH CBSA. The ASKY site is located behind the county health department, in a residential area in the center of town, as shown in Figure 12-1. The ASKY-M site is located on the roof of an oil company complex in the north-central part of Ashland, which is more industrial. The ASKY-M monitoring site is located less than one-quarter mile from the Ohio River, as shown in Figure 12-2, and a rail yard, a scrap yard, and other industries are located between the site and the river.

ASKY and ASKY-M are approximately 1.25 miles apart, as shown in Figure 12-3. Most of the emissions sources near these sites are located along the Ohio River and its tributary to the south, the Big Sandy River. These emissions sources reflect a variety of industries including asphalt production, chemical manufacturing, food processing, metals processing/fabrication, pesticide manufacturing, petroleum refining, and ship/boat manufacturing, to name a few. A cluster of emissions sources is located very close to ASKY-M, within a half-mile, such that the symbol for the site hides the symbols for the facilities. This cluster includes a testing laboratory, a miscellaneous commercial/industrial facility, a mine/quarry, and a heliport at a hospital. There are no emissions sources within a half-mile of ASKY. The closest sources to ASKY are the same ones under the symbol for ASKY-M, although a coke battery and a ship/boat manufacturing or repair facility are located a little farther to the east of ASKY.

Grayson Lake is located in northeast Kentucky, south of the town of Grayson, and southwest of the Huntington-Ashland, WV-KY-OH CBSA. The Little Sandy River feeds into Grayson Lake, which is a U.S. Army Corps of Engineers-managed project, and part of the Kentucky State Parks system. The lake is narrow and winding, with sandstone cliffs rising to up to 200 feet above the lake surface (KY, 2018; ACE, 2018). The closest road to the monitoring site is a service road feeding into Camp Grayson, as shown in Figure 12-4. This site serves as the Grayson Lake NATTS site. Figure 12-5 shows that few point sources surround GLKY and that most of them are on the outer periphery of the 10-mile boundary around GLKY. This is not surprising given the rural nature of the area and that Grayson Lake is located roughly in the center of the 10-mile boundary in Figure 12-5. Sources within 10 miles of GLKY are involved in brick/structural clay/clay ceramics manufacturing, food processing, and mining, among others.

The BAKY monitoring site is located at the Baskett Fire Department in Baskett, a small rural town in northwest Kentucky. Baskett is northeast of Henderson and south of Evansville, Indiana. The Ohio River is the border between Kentucky and Indiana and meanders through the area, with the Green River, a tributary of the Ohio River, just over 1 mile north of the site at the closest point. The fire department property backs up to a rail line that runs through town. Open fields surround the town, as shown in Figure 12-6. There are no emissions sources within a few miles of BAKY, as shown in Figure 12-7. The cluster of emissions sources to the southwest of BAKY are located in or near Henderson, while the sources to the northwest are located in Evansville.

Three monitoring sites are located in and around the Calvert City area. Calvert City is located on the Tennessee River, east of the Paducah metro area, approximately 6 miles southeast of the Ohio River and the Kentucky/Illinois border. The northern half of the city is highly industrialized while the southern half is primarily residential, with a rail line that transverses the area acting as a pseudo-dividing line. The city is home to some 16 industrial plants, including metal, steel, and chemical plants (Calvert City, 2018).

The ATKY monitoring site is located off Main Street (State Road 95), just south of the entrance to a chemical manufacturing plant. The majority of the city's industry lies north and east of ATKY. Just over one mile east-northeast of ATKY is the TVKY monitoring site. This monitoring site is located at a power substation just south of another chemical manufacturing plant. BLKY, the third monitoring site in the Calvert City area, is located across the Tennessee River, north of Calvert City, in Smithland. The site is located on a residential property in an agricultural area. This site is potentially downwind of the Calvert City industrial area. These sites roughly form a triangle around the industrial area of Calvert City. Composite satellite images for these sites are provided in alphabetical order by site in Figures 12-8 through 12-10.

Figure 12-11 is the facility map for the Calvert City sites and provides an indication of how close these sites are to one another. Most of the emissions sources in Calvert City are located between ATKY, TVKY, and the Tennessee River. Many of the emissions sources closest to the Calvert City sites are in the chemical manufacturing or plastic, resin, or rubber product source categories. Industries located farther away from the sites but within 10 miles include ship/boat manufacturing or repair; mine, quarry, or mineral processing; a steel mill; metals processing/fabrication, and an asphalt production/hot mix asphalt plant.

The LEKY monitoring site is located in the city of Lexington in north-central Kentucky. The site is located on the property of the county health department in a primarily residential area of northern Lexington. A YMCA is located adjacent to the health department along W. Loudon Avenue and a community college is located immediately to the south. The mental health facility formerly located on the property has been demolished after relocating. Although the area is residential and suburban, most of the residences are located to the west of Newtown Pike (922). An electrical equipment and ink manufacturer is located to the northeast of the site, as shown in Figure 12-12. LEKY is located just over a half-mile south of New Circle Road (4/421), a loop encircling the city of Lexington. Figure 12-13 shows that most of the emissions sources within 10 miles of LEKY are within a few miles of the site. Emissions sources within 1 mile of LEKY include the aforementioned electrical equipment manufacturing plant, a food processing plant, an institution, and a metals processing and fabrication facility.

In addition to providing city, county, CBSA, and land use/location setting information, Table 12-1 also contains traffic volume information for each site as well as the location for which the traffic volume was obtained. This information is provided because emissions from motor vehicles can significantly affect concentrations measured at a given monitoring site. Among these sites, traffic volume is highest near LEKY and ASKY-M and lowest near GLKY and BAKY. Traffic counts for all of the Kentucky sites are in the bottom half of the range compared to other NMP sites, with the traffic near GLKY the lowest among all NMP sites.

12.2 Pollutants of Interest

The risk-based screening process described in Section 3.2 was performed for each monitoring site to identify site-specific "pollutants of interest," which allows analysts and readers to focus on a subset of pollutants through the context of risk. For each site, each pollutant's preprocessed daily measurement was compared to its associated risk screening value. If the concentration was greater than the risk screening value, then the concentration "failed the screen." Pollutants of interest are those for which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens.

It is important to note which pollutants were sampled for at each site when reviewing the results of this analysis. Table 12-2 provides an overview of which pollutant groups were sampled for at each site. The site-specific results of the risk-based screening process are presented in Table 12-3 and incorporate measurements from both 2015 and 2016, with the pollutants of interest for each site shaded in gray in Table 12-3.

Table 12-2. Overview of Pollutant Groups Sampled for at the Kentucky Monitoring Sites

Site	VOCs	Carbonyl Compounds	PAHs	PM_{10} Metals
ASKY	✓	--	--	--
ASKY-M	--	--	--	✓
GLKY	✓	✓	✓	✓
BAKY	--	--	--	✓
ATKY	✓	--	--	--
BLKY	✓	--	--	✓
TVKY	✓	--	--	--
LEKY	✓	--	--	✓

-- = This pollutant group was not sampled for at this site.
BOLD ITALICS = EPA-designated NATTS Site

Observations from Table 12-2 include the following:

- Carbonyl compounds, VOCs, PAHs, and PM_{10} metals were sampled for at GLKY.
- Additional sites sampling PM_{10} metals include ASKY-M, BAKY, BLKY, and LEKY.
- Additional sites sampling VOCs include ASKY, ATKY, BLKY, TVKY, and LEKY.
- No additional sites sampled carbonyl compounds or PAHs.

Table 12-3. 2015-2016 Risk-Based Screening Results for the Kentucky Monitoring Sites

Pollutant	Screening Value ($\mu g/m^3$)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Health Department, Ashland, Kentucky - ASKY						
Benzene	0.13	120	120	100.00	25.21	25.21
Carbon Tetrachloride	0.17	119	120	99.17	25.00	50.21
1,2-Dichloroethane	0.038	111	112	99.11	23.32	73.53
1,3-Butadiene	0.03	98	111	88.29	20.59	94.12
Hexachloro-1,3-butadiene	0.045	14	17	82.35	2.94	97.06
p-Dichlorobenzene	0.091	6	59	10.17	1.26	98.32
Ethylbenzene	0.4	5	120	4.17	1.05	99.37
1,2-Dibromoethane	0.0017	3	3	100.00	0.63	100.00
Total		476	662	71.90		

Table 12-3. 2015-2016 Risk-Based Screening Results for the Kentucky Monitoring Sites (Continued)

Pollutant	Screening Value (µg/m^3)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
21st and Greenup, Ashland, Kentucky - ASKY-M						
Arsenic (PM_{10})	0.00023	106	110	96.36	53.81	53.81
Nickel (PM_{10})	0.0021	38	110	34.55	19.29	73.10
Manganese (PM_{10})	0.03	25	110	22.73	12.69	85.79
Cadmium (PM_{10})	0.00056	15	110	13.64	7.61	93.40
Lead (PM_{10})	0.015	13	110	11.82	6.60	100.00
Total		197	550	35.82		
Grayson, Kentucky - GLKY						
Carbon Tetrachloride	0.17	121	121	100.00	15.71	15.71
Formaldehyde	0.077	121	121	100.00	15.71	31.43
Benzene	0.13	120	121	99.17	15.58	47.01
Acetaldehyde	0.45	118	121	97.52	15.32	62.34
1,2-Dichloroethane	0.038	106	109	97.25	13.77	76.10
Arsenic (PM_{10})	0.00023	103	116	88.79	13.38	89.48
1,3-Butadiene	0.03	58	98	59.18	7.53	97.01
Naphthalene	0.029	10	120	8.33	1.30	98.31
Hexachloro-1,3-butadiene	0.045	7	9	77.78	0.91	99.22
1,2-Dibromoethane	0.0017	3	3	100.00	0.39	99.61
Cadmium (PM_{10})	0.00056	1	117	0.85	0.13	99.74
Manganese (PM_{10})	0.03	1	117	0.85	0.13	99.87
Nickel (PM_{10})	0.0021	1	117	0.85	0.13	100.00
Total		770	1,290	59.69		
Baskett, Kentucky - BAKY						
Arsenic (PM_{10})	0.00023	108	114	94.74	95.58	95.58
Nickel (PM_{10})	0.0021	2	113	1.77	1.77	97.35
Antimony (PM_{10})	0.02	1	114	0.88	0.88	98.23
Lead (PM_{10})	0.015	1	114	0.88	0.88	99.12
Manganese (PM_{10})	0.03	1	114	0.88	0.88	100.00
Total		113	569	19.86		

Table 12-3. 2015-2016 Risk-Based Screening Results for the Kentucky Monitoring Sites (Continued)

Pollutant	Screening Value (µg/m^3)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Atmos Energy, Calvert City, Kentucky - ATKY						
Benzene	0.13	120	120	100.00	22.47	22.47
Carbon Tetrachloride	0.17	120	120	100.00	22.47	44.94
1,2-Dichloroethane	0.038	119	119	100.00	22.28	67.23
1,3-Butadiene	0.03	77	108	71.30	14.42	81.65
Vinyl chloride	0.11	56	95	58.95	10.49	92.13
Hexachloro-1,3-butadiene	0.045	15	17	88.24	2.81	94.94
1,1,2-Trichloroethane	0.0625	12	15	80.00	2.25	97.19
1,2-Dibromoethane	0.0017	6	6	100.00	1.12	98.31
Ethylbenzene	0.4	3	120	2.50	0.56	98.88
Trichloroethylene	0.2	3	32	9.38	0.56	99.44
p-Dichlorobenzene	0.091	1	27	3.70	0.19	99.63
1,1-Dichloroethane	0.625	1	31	3.23	0.19	99.81
Xylenes	10	1	120	0.83	0.19	100.00
Total		534	930	57.42		
Smithland, Kentucky - BLKY						
Benzene	0.13	119	119	100.00	19.51	19.51
Carbon Tetrachloride	0.17	119	119	100.00	19.51	39.02
1,2-Dichloroethane	0.038	117	117	100.00	19.18	58.20
Arsenic (PM_{10})	0.00023	98	109	89.91	16.07	74.26
1,3-Butadiene	0.03	66	100	66.00	10.82	85.08
Vinyl chloride	0.11	46	88	52.27	7.54	92.62
Hexachloro-1,3-butadiene	0.045	18	23	78.26	2.95	95.57
1,1,2-Trichloroethane	0.0625	11	14	78.57	1.80	97.38
1,2-Dibromoethane	0.0017	10	10	100.00	1.64	99.02
Manganese (PM_{10})	0.03	2	110	1.82	0.33	99.34
Nickel (PM_{10})	0.0021	2	109	1.83	0.33	99.67
p-Dichlorobenzene	0.091	1	29	3.45	0.16	99.84
Trichloroethylene	0.2	1	24	4.17	0.16	100.00
Total		610	971	62.82		

Table 12-3. 2015-2016 Risk-Based Screening Results for the Kentucky Monitoring Sites (Continued)

Pollutant	Screening Value (µg/m^3)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
TVA Substation, Calvert City, Kentucky - TVKY						
Benzene	0.13	123	123	100.00	22.32	22.32
Carbon Tetrachloride	0.17	123	123	100.00	22.32	44.65
1,2-Dichloroethane	0.038	122	122	100.00	22.14	66.79
1,3-Butadiene	0.03	82	108	75.93	14.88	81.67
Vinyl chloride	0.11	58	95	61.05	10.53	92.20
1,1,2-Trichloroethane	0.0625	23	29	79.31	4.17	96.37
Hexachloro-1,3-butadiene	0.045	12	16	75.00	2.18	98.55
1,2-Dibromoethane	0.0017	4	4	100.00	0.73	99.27
Chloroprene	0.0021	2	2	100.00	0.36	99.64
1,1-Dichloroethane	0.625	2	46	4.35	0.36	100.00
Total		551	668	82.49		
Lexington, Kentucky - LEKY						
Arsenic (PM_{10})	0.00023	97	103	94.17	22.61	22.61
Benzene	0.13	82	82	100.00	19.11	41.72
Carbon Tetrachloride	0.17	82	82	100.00	19.11	60.84
1,2-Dichloroethane	0.038	78	80	97.50	18.18	79.02
1,3-Butadiene	0.03	66	75	88.00	15.38	94.41
p-Dichlorobenzene	0.091	7	35	20.00	1.63	96.04
Hexachloro-1,3-butadiene	0.045	6	6	100.00	1.40	97.44
Ethylbenzene	0.4	5	82	6.10	1.17	98.60
1,2-Dibromoethane	0.0017	2	2	100.00	0.47	99.07
Manganese (PM_{10})	0.03	1	103	0.97	0.23	99.30
Nickel (PM_{10})	0.0021	1	103	0.97	0.23	99.53
1,1,2-Trichloroethane	0.0625	1	2	50.00	0.23	99.77
Trichloroethylene	0.2	1	8	12.50	0.23	100.00
Total		429	763	56.23		

Observations for the Ashland sites from Table 12-3 include the following:

- The pollutants failing screens is very different between these two monitoring sites; this is expected given the different pollutants measured at each site. As shown in Table 12-2, VOCs were sampled for at ASKY while PM_{10} metals were sampled for at ASKY-M.

- Concentrations of eight VOCs failed at least one screen for ASKY, with 72 percent of concentrations for these eight pollutants greater than their associated risk screening value (or failing screens).

- Five VOCs contributed to 95 percent of failed screens for ASKY and therefore were identified as pollutants of interest. These five are benzene, 1,3-butadiene, carbon tetrachloride, 1,2-dichloroethane, and hexachloro-1,3-butadiene.

- Concentrations of five metals failed at least one screen for ASKY-M, with 36 percent of concentrations for these five pollutants greater than their associated risk screening value (or failing screens).

- All five of these metals (arsenic, nickel, manganese, cadmium, and lead) contributed to 95 percent of failed screens for ASKY-M and therefore were identified as pollutants of interest. ASKY-M is the only NMP site with lead as a pollutant of interest. ASKY-M is one of only two NMP sites with manganese as a pollutant of interest (TOOK is the other). This is also true for cadmium (BOMA is the other site).

Observations for GLKY from Table 12-3 include the following:

- All four pollutant groups shown in Table 12-2 were sampled for at GLKY.

- Concentrations of 13 pollutants failed at least one screen for GLKY, with nearly 60 percent of concentrations for these 13 pollutants greater than their associated risk screening value (or failing screens).

- Seven pollutants contributed to 95 percent of failed screens for GLKY and therefore were identified as pollutants of interest. These include two carbonyl compounds, four VOCs, and one metal.

Observations for BAKY from Table 12-3 include the following:

- BAKY sampled for PM_{10} metals only.

- Concentrations of five PM_{10} metals failed at least one screen for BAKY, although a single metal (arsenic) accounts for 108 of 113 of the total failed screens. Only one or two concentrations for each of the other PM_{10} metals failed screens.

- With arsenic contributing to 96 percent of the failed screens for BAKY, this pollutant was identified as BAKY's sole pollutant of interest.

Observations for the Calvert City sites from Table 12-3 include the following:

- VOCs were sampled for at all three Calvert City sites. PM_{10} metals were also sampled for at BLKY.

- Concentrations of 13 VOCs failed screens for ATKY; seven of these VOCs contributed to 95 percent of failed screens for ATKY and thus, were identified as pollutants of interest for this site.

- Concentrations of 13 pollutants failed screens for BLKY; seven VOCs and one PM_{10} metal (arsenic) contributed to 95 percent of failed screens for BLKY and thus, were identified as pollutants of interest for this site.

- Concentrations of 10 VOCs failed screens for TVKY; six of these VOCs contributed to 95 percent of failed screens for TVKY and thus, were identified as pollutants of interest for this site.

- Benzene, carbon tetrachloride, 1,2-dichloroethane, 1,3-butadiene, and vinyl chloride were identified as pollutants of interest for all thee Calvert City sites. These sites are the only NMP sites with vinyl chloride as a pollutant of interest.

Observations for LEKY from Table 12-3 include the following:

- VOCs and PM_{10} metals were sampled for at LEKY.

- Concentrations of 13 pollutants failed at least one screen for LEKY, with 56 percent of concentrations of these 13 pollutants greater than their associated risk screening value (or failing screens).

- Six pollutants contributed to 95 percent of failed screens for LEKY and therefore were identified as pollutants of interest. These include five VOCs and one metal.

12.3 Concentrations

This section presents various concentration averages used to characterize air toxics concentration levels at the Kentucky monitoring sites. Where applicable, the following calculations and data analyses were performed for each of the site-specific pollutants of interest:

- Time period-based concentration averages (quarterly and annual) are provided for each monitoring site for each year.

- The range of measurements and annual average concentrations are presented graphically for each site to illustrate how the site's concentrations compare to the program-level averages, as presented in Section 4.1.

- Concentration averages and other statistical metrics for 2015, 2016, and from previous years of monitoring are presented in order to characterize concentration trends at each site.

Each data analysis is performed where the applicable criteria are met (as specified in the appropriate sections discussed below) and is limited to the site-specific pollutants of interest. However, site-specific statistical summaries for all pollutants sampled for at the Kentucky monitoring sites are provided in Appendices J, M, N, and O.

12.3.1 2015 and 2016 Concentration Averages

Quarterly and annual concentration averages were calculated for 2015 and 2016 for the pollutants of interest for the Kentucky sites, as described in Section 3.1. The *quarterly average concentration* of a particular pollutant is simply the average concentration of the preprocessed daily measurements over a given calendar quarter. Quarterly average concentrations include the substitution of zeros for all non-detects. A site must have a minimum of 75 percent valid samples compared to the total number of samples possible within a given calendar quarter for a quarterly average to be calculated. An *annual average concentration* includes all measured detections and substituted zeros for non-detects for an entire year of sampling. Annual averages were calculated for pollutants where three valid quarterly averages could be calculated for a given year and where method completeness was greater than or equal to 85 percent, as presented in Section 2.4. Quarterly and annual average concentrations for the pollutants of interest for the Kentucky monitoring sites are presented in Table 12-4, where applicable. Note that concentrations of the PAHs and metals are presented in ng/m^3 for ease of viewing. Also note that if a pollutant was not detected in a given calendar quarter, the quarterly average simply reflects "0" because only zeros substituted for non-detects were factored into the quarterly average concentration.

Table 12-4. Quarterly and Annual Average Concentrations of the Pollutants of Interest for the Kentucky Monitoring Sites

Pollutant	2015 # of Detects/ # >MDL/ # Samples	2015 Q1 Avg (µg/m³)	2015 Q2 Avg (µg/m³)	2015 Q3 Avg (µg/m³)	2015 Q4 Avg (µg/m³)	2015 Annual Average (µg/m³)	2016 # of Detects/ # >MDL/ # Samples	2016 Q1 Avg (µg/m³)	2016 Q2 Avg (µg/m³)	2016 Q3 Avg (µg/m³)	2016 Q4 Avg (µg/m³)	2016 Annual Average (µg/m³)
Health Department, Ashland, Kentucky - ASKY												
Benzene	60/60/60	0.80 ± 0.19	0.74 ± 0.33	0.69 ± 0.16	0.88 ± 0.22	0.78 ± 0.11	60/60/60	0.91 ± 0.22	0.49 ± 0.10	0.51 ± 0.11	0.69 ± 0.25	0.65 ± 0.10
1,3-Butadiene	56/50/60	0.06 ± 0.02	0.07 ± 0.02	0.05 ± 0.01	0.08 ± 0.02	0.06 ± 0.01	55/25/60	0.09 ± 0.03	0.06 ± 0.02	0.04 ± 0.01	0.07 ± 0.03	0.06 ± 0.01
Carbon Tetrachloride	60/60/60	0.55 ± 0.09	0.62 ± 0.03	0.67 ± 0.02	0.63 ± 0.05	0.62 ± 0.03	60/60/60	0.63 ± 0.04	0.70 ± 0.05	0.65 ± 0.04	0.58 ± 0.04	0.64 ± 0.02
1,2-Dichloroethane	59/49/60	0.09 ± 0.01	0.07 ± 0.02	0.06 ± 0.01	0.08 ± 0.01	0.08 ± 0.01	53/50/60	0.09 ± 0.01	0.08 ± 0.01	0.05 ± 0.02	0.06 ± 0.02	0.07 ± 0.01
Hexachloro-1,3-butadiene	2/0/60	NR	NR	NR	NR	NR	15/0/60	0.02 ± 0.02	0.02 ± 0.02	0.01 ± 0.02	0.02 ± 0.02	0.02 ± 0.01
21st and Greenup, Ashland, Kentucky - ASKY-M												
Arsenic (PM_{10})[a]	55/55/55	0.78 ± 0.26	1.94 ± 0.95	1.44 ± 0.52	1.32 ± 0.47	1.38 ± 0.32	55/55/55	1.00 ± 0.47	1.34 ± 0.45	NA	1.18 ± 0.55	1.13 ± 0.23
Cadmium (PM_{10})[a]	55/55/55	0.32 ± 0.20	0.44 ± 0.23	0.29 ± 0.07	0.23 ± 0.08	0.32 ± 0.08	55/55/55	0.68 ± 0.74	0.31 ± 0.13	NA	0.20 ± 0.09	0.39 ± 0.22
Lead (PM_{10})[a]	55/55/55	8.34 ± 4.54	11.57 ± 5.98	8.88 ± 2.48	6.34 ± 2.26	8.83 ± 2.08	55/55/55	6.78 ± 2.93	8.81 ± 4.08	NA	7.40 ± 4.92	6.97 ± 1.86
Manganese (PM_{10})[a]	55/55/55	25.75 ± 13.87	33.28 ± 15.13	23.71 ± 6.32	16.67 ± 6.30	25.05 ± 5.70	55/55/55	20.65 ± 10.28	26.86 ± 12.18	NA	16.77 ± 7.69	19.85 ± 4.75
Nickel (PM_{10})[a]	55/53/55	2.24 ± 1.52	2.26 ± 0.86	2.21 ± 0.83	2.09 ± 0.72	2.20 ± 0.49	55/55/55	3.26 ± 1.78	2.06 ± 0.87	NA	1.71 ± 0.90	2.12 ± 0.62

NA = Not available because the criteria for calculating a quarterly and/or annual average were not met.
NS = Sampling was not conducted during this time.
NR = Not reportable due to invalidation related to a contaminated internal standard.
[a] Average concentrations provided for the pollutants below the blue line are presented in ng/m³ for ease of viewing.

Table 12-4. Quarterly and Annual Average Concentrations of the Pollutants of Interest for the Kentucky Monitoring Sites (Continued)

Pollutant	2015 # of Detects/ # >MDL/ # Samples	2015 Q1 Avg (µg/m³)	2015 Q2 Avg (µg/m³)	2015 Q3 Avg (µg/m³)	2015 Q4 Avg (µg/m³)	2015 Annual Average (µg/m³)	2016 # of Detects/ # >MDL/ # Samples	2016 Q1 Avg (µg/m³)	2016 Q2 Avg (µg/m³)	2016 Q3 Avg (µg/m³)	2016 Q4 Avg (µg/m³)	2016 Annual Average (µg/m³)
Grayson, Kentucky - GLKY												
Acetaldehyde	60/60/60	0.92 ± 0.11	1.13 ± 0.17	0.77 ± 0.10	0.67 ± 0.12	0.87 ± 0.07	61/61/61	0.69 ± 0.07	1.06 ± 0.27	0.76 ± 0.09	0.93 ± 0.30	0.86 ± 0.10
Benzene	60/60/60	0.56 ± 0.10	0.28 ± 0.05	0.31 ± 0.05	0.42 ± 0.08	0.39 ± 0.04	61/61/61	0.46 ± 0.05	0.26 ± 0.03	0.28 ± 0.05	0.54 ± 0.12	0.39 ± 0.04
1,3-Butadiene	51/28/60	0.03 ± 0.01	0.03 ± 0.01	0.03 ± 0.01	0.04 ± 0.01	0.03 ± 0.01	47/7/61	0.04 ± 0.01	0.02 ± 0.01	0.03 ± 0.01	0.04 ± 0.01	0.03 ± 0.01
Carbon Tetrachloride	60/60/60	0.63 ± 0.03	0.60 ± 0.03	0.65 ± 0.04	0.62 ± 0.07	0.62 ± 0.02	61/61/61	0.61 ± 0.04	0.68 ± 0.04	0.64 ± 0.06	0.59 ± 0.05	0.63 ± 0.02
1,2-Dichloroethane	58/40/60	0.08 ± 0.01	0.07 ± 0.01	0.04 ± 0.01	0.06 ± 0.01	0.06 ± 0.01	51/44/61	0.07 ± <0.01	0.07 ± 0.01	0.03 ± 0.02	0.05 ± 0.02	0.06 ± 0.01
Formaldehyde	60/60/60	1.06 ± 0.21	2.55 ± 0.54	2.40 ± 0.35	1.03 ± 0.23	1.76 ± 0.25	61/61/61	1.15 ± 0.17	2.40 ± 0.57	2.34 ± 0.31	1.65 ± 0.53	1.87 ± 0.24
Arsenic (PM_{10})[a]	57/56/58	0.40 ± 0.13	0.53 ± 0.19	0.67 ± 0.20	0.57 ± 0.22	0.54 ± 0.09	59/59/59	0.46 ± 0.25	0.60 ± 0.18	0.63 ± 0.32	0.44 ± 0.12	0.53 ± 0.11
Baskett, Kentucky - BAKY												
Arsenic (PM_{10}) [a]	56/54/56	0.59 ± 0.13	0.95 ± 0.26	1.49 ± 0.44	0.74 ± 0.41	0.96 ± 0.19	58/58/58	0.49 ± 0.14	1.07 ± 0.33	1.34 ± 0.26	0.84 ± 0.34	0.92 ± 0.15

NA = Not available because the criteria for calculating a quarterly and/or annual average were not met.
NS = Sampling was not conducted during this time.
NR = Not reportable due to invalidation related to a contaminated internal standard.
[a] Average concentrations provided for the pollutants below the blue line are presented in ng/m³ for ease of viewing.

Table 12-4. Quarterly and Annual Average Concentrations of the Pollutants of Interest for the Kentucky Monitoring Sites (Continued)

Pollutant	2015						2016					
	# of Detects/ # >MDL/ # Samples	Q1 Avg (µg/m³)	Q2 Avg (µg/m³)	Q3 Avg (µg/m³)	Q4 Avg (µg/m³)	Annual Average (µg/m³)	# of Detects/ # >MDL/ # Samples	Q1 Avg (µg/m³)	Q2 Avg (µg/m³)	Q3 Avg (µg/m³)	Q4 Avg (µg/m³)	Annual Average (µg/m³)
Atmos Energy, Calvert City, Kentucky - ATKY												
Benzene	59/59/59	0.68 ± 0.15	0.90 ± 0.71	1.22 ± 0.71	1.01 ± 0.89	0.96 ± 0.32	61/61/61	0.55 ± 0.11	0.49 ± 0.08	0.72 ± 0.41	0.53 ± 0.09	0.57 ± 0.10
1,3-Butadiene	56/39/59	0.09 ± 0.04	0.05 ± 0.02	0.06 ± 0.04	0.04 ± 0.02	0.06 ± 0.02	52/22/61	0.03 ± 0.02	0.05 ± 0.02	0.06 ± 0.03	0.05 ± 0.02	0.05 ± 0.01
Carbon Tetrachloride	59/59/59	0.66 ± 0.03	0.65 ± 0.03	0.73 ± 0.10	0.65 ± 0.03	0.67 ± 0.03	61/61/61	0.64 ± 0.04	0.72 ± 0.04	0.73 ± 0.09	0.66 ± 0.05	0.69 ± 0.03
1,2-Dichloroethane	59/58/59	0.37 ± 0.25	0.31 ± 0.24	0.77 ± 0.67	0.19 ± 0.12	0.41 ± 0.19	60/59/61	0.12 ± 0.05	1.39 ± 1.72	1.89 ± 1.42	0.26 ± 0.15	0.90 ± 0.55
Hexachloro-1,3-butadiene	3/0/59	NR	NR	NR	NR	NR	14/0/61	0	0.03 ± 0.02	0.03 ± 0.03	0.02 ± 0.02	0.02 ± 0.01
1,1,2-Trichloroethane	6/1/59	0	<0.01 ± 0.01	0.01 ± 0.01	0.02 ± 0.03	0.01 ± 0.01	9/9/61	0	0.02 ± 0.03	0.30 ± 0.33	0.04 ± 0.05	0.09 ± 0.08
Vinyl chloride	45/41/59	0.87 ± 0.62	0.22 ± 0.29	1.00 ± 0.67	0.58 ± 0.87	0.69 ± 0.32	50/30/61	0.28 ± 0.34	0.72 ± 0.46	1.37 ± 1.34	1.00 ± 1.78	0.83 ± 0.54

NA = Not available because the criteria for calculating a quarterly and/or annual average were not met.
NS = Sampling was not conducted during this time.
NR = Not reportable due to invalidation related to a contaminated internal standard.
[a] Average concentrations provided for the pollutants below the blue line are presented in ng/m³ for ease of viewing.

Table 12-4. Quarterly and Annual Average Concentrations of the Pollutants of Interest for the Kentucky Monitoring Sites (Continued)

Pollutant	2015						2016					
	# of Detects/ # >MDL/ # Samples	Q1 Avg (µg/m³)	Q2 Avg (µg/m³)	Q3 Avg (µg/m³)	Q4 Avg (µg/m³)	Annual Average (µg/m³)	# of Detects/ # >MDL/ # Samples	Q1 Avg (µg/m³)	Q2 Avg (µg/m³)	Q3 Avg (µg/m³)	Q4 Avg (µg/m³)	Annual Average (µg/m³)
Smithland, Kentucky - BLKY												
Benzene	59/59/59	0.55 ± 0.09	0.59 ± 0.15	0.57 ± 0.15	0.54 ± 0.14	0.56 ± 0.06	60/60/60	0.57 ± 0.10	0.43 ± 0.13	0.45 ± 0.18	0.53 ± 0.15	0.49 ± 0.07
1,3-Butadiene	51/33/59	0.03 ± 0.02	0.11 ± 0.05	0.03 ± 0.01	0.07 ± 0.04	0.06 ± 0.02	49/18/60	0.05 ± 0.03	0.05 ± 0.04	0.08 ± 0.09	0.06 ± 0.03	0.06 ± 0.03
Carbon Tetrachloride	59/59/59	0.60 ± 0.06	0.67 ± 0.04	0.68 ± 0.04	0.73 ± 0.10	0.67 ± 0.03	60/60/60	0.69 ± 0.09	0.79 ± 0.07	0.76 ± 0.08	0.70 ± 0.08	0.73 ± 0.04
1,2-Dichloroethane	59/56/59	0.16 ± 0.10	1.37 ± 0.75	0.52 ± 0.33	0.79 ± 0.77	0.72 ± 0.29	58/57/60	3.47 ± 6.23	0.94 ± 0.78	1.91 ± 1.57	1.24 ± 0.83	1.89 ± 1.55
Hexachloro-1,3-butadiene	6/0/59	NR	NR	NR	NR	NR	17/0/60	0.01 ± 0.01	0.05 ± 0.03	0.02 ± 0.03	0.02 ± 0.02	0.03 ± 0.01
Vinyl chloride	41/37/59	0.04 ± 0.05	0.14 ± 0.07	0.10 ± 0.08	0.13 ± 0.08	0.10 ± 0.04	47/27/60	0.28 ± 0.25	0.08 ± 0.07	0.15 ± 0.10	0.16 ± 0.11	0.17 ± 0.07
Arsenic (PM_{10}) [a]	50/49/51	0.55 ± 0.16	0.55 ± 0.16	0.67 ± 0.15	NA	0.57 ± 0.09	59/59/59	0.40 ± 0.09	0.63 ± 0.17	0.61 ± 0.12	0.56 ± 0.15	0.54 ± 0.07

NA = Not available because the criteria for calculating a quarterly and/or annual average were not met.
NS = Sampling was not conducted during this time.
NR = Not reportable due to invalidation related to a contaminated internal standard.
[a] Average concentrations provided for the pollutants below the blue line are presented in ng/m³ for ease of viewing.

Table 12-4. Quarterly and Annual Average Concentrations of the Pollutants of Interest for the Kentucky Monitoring Sites (Continued)

Pollutant	2015 # of Detects/ # >MDL/ # Samples	2015 Q1 Avg (µg/m³)	2015 Q2 Avg (µg/m³)	2015 Q3 Avg (µg/m³)	2015 Q4 Avg (µg/m³)	2015 Annual Average (µg/m³)	2016 # of Detects/ # >MDL/ # Samples	2016 Q1 Avg (µg/m³)	2016 Q2 Avg (µg/m³)	2016 Q3 Avg (µg/m³)	2016 Q4 Avg (µg/m³)	2016 Annual Average (µg/m³)
TVA Substation, Calvert City, Kentucky - TVKY												
Benzene	62/62/62	1.20 ± 0.66	1.04 ± 0.73	1.14 ± 0.72	0.78 ± 0.36	1.04 ± 0.30	61/61/61	0.62 ± 0.17	0.53 ± 0.17	0.43 ± 0.24	0.57 ± 0.16	0.54 ± 0.09
1,3-Butadiene	56/43/62	0.44 ± 0.38	0.35 ± 0.35	0.33 ± 0.33	0.29 ± 0.49	0.35 ± 0.19	52/21/61	0.11 ± 0.11	0.39 ± 0.49	0.05 ± 0.05	0.08 ± 0.07	0.16 ± 0.12
Carbon Tetrachloride	62/62/62	0.93 ± 0.27	0.70 ± 0.04	0.94 ± 0.42	0.83 ± 0.24	0.85 ± 0.13	61/61/61	0.70 ± 0.05	0.93 ± 0.32	0.85 ± 0.24	0.72 ± 0.06	0.80 ± 0.10
1,2-Dichloroethane	62/61/62	4.73 ± 3.95	5.02 ± 3.76	2.72 ± 2.48	2.57 ± 2.55	3.75 ± 1.56	60/60/61	4.63 ± 3.56	3.47 ± 2.31	1.14 ± 0.96	4.63 ± 3.33	3.49 ± 1.36
1,1,2-Trichloroethane	13/9/62	0.03 ± 0.02	0.01 ± 0.01	0.02 ± 0.03	0.06 ± 0.08	0.03 ± 0.02	16/10/61	0.03 ± 0.03	0.05 ± 0.05	<0.01 ± 0.01	0.32 ± 0.33	0.09 ± 0.08
Vinyl chloride	42/41/62	0.30 ± 0.20	0.23 ± 0.16	0.30 ± 0.33	0.35 ± 0.30	0.30 ± 0.12	53/32/61	0.21 ± 0.14	0.44 ± 0.30	0.11 ± 0.08	0.53 ± 0.29	0.31 ± 0.11
Lexington, Kentucky - LEKY												
Benzene	53/53/53	0.58 ± 0.09	0.49 ± 0.13	0.45 ± 0.10	NA	0.51 ± 0.06	29/29/29	0.52 ± 0.10	0.35 ± 0.06	NA	NS	NA
1,3-Butadiene	47/44/53	0.04 ± 0.02	0.07 ± 0.03	0.06 ± 0.02	NA	0.06 ± 0.01	28/9/29	0.05 ± 0.03	0.05 ± 0.02	NA	NS	NA
Carbon Tetrachloride	53/53/53	0.61 ± 0.04	0.60 ± 0.04	0.66 ± 0.03	NA	0.63 ± 0.02	29/29/29	0.68 ± 0.04	0.71 ± 0.03	NA	NS	NA
p-Dichlorobenzene	26/2/53	0.02 ± 0.01	0.04 ± 0.03	0.04 ± 0.02	NA	0.03 ± 0.01	9/0/29	0.02 ± 0.02	0.03 ± 0.02	NA	NS	NA
1,2-Dichloroethane	51/40/53	0.08 ± 0.01	0.07 ± 0.01	0.05 ± 0.01	NA	0.07 ± 0.01	29/29/29	0.09 ± 0.01	0.08 ± 0.01	NA	NS	NA
Arsenic (PM_{10})[a]	56/56/56	0.60 ± 0.14	0.75 ± 0.18	0.80 ± 0.18	1.06 ± 0.60	0.81 ± 0.17	47/47/47	NA	0.78 ± 0.16	NA	0.81 ± 0.28	NA

NA = Not available because the criteria for calculating a quarterly and/or annual average were not met.
NS = Sampling was not conducted during this time.
NR = Not reportable due to invalidation related to a contaminated internal standard.
[a] Average concentrations provided for the pollutants below the blue line are presented in ng/m³ for ease of viewing.

Observations for the Ashland sites from Table 12-4 include the following:

- VOCs were sampled for at ASKY and PM_{10} metals were sampled for at ASKY-M. Thus, these sites have no pollutants of interest in common.

- For 2015, benzene is the pollutant of interest with the highest annual average concentration for ASKY (0.78 ± 0.11 µg/m^3), followed by carbon tetrachloride (0.62 ± 0.03 µg/m^3). The annual averages for these two pollutants are an order of magnitude greater than the annual averages for 1,3-butadiene and 1,2-dichloroethane. For 2016, this is also true, but the difference between the annual averages of benzene (0.65 ± 0.10 µg/m^3) and carbon tetrachloride (0.64 ± 0.02 µg/m^3) is negligible.

- Concentrations of benzene measured at ASKY range from 0.157 µg/m^3 to 2.80 µg/m^3. Quarterly average concentrations exhibit considerable variability, particularly for 2016, when the first quarter average (0.91 ± 0.22 µg/m^3) is almost twice the second quarter average (0.49 ± 0.10 µg/m^3). In 2016, two-thirds of the nine benzene concentrations greater than 1 µg/m^3 were measured during the first quarter of the year, compared to none during the second and third quarters and three during the fourth. By comparison, 14 benzene concentrations greater than 1 µg/m^3 were measured in 2015, but at least one was measured during each calendar quarter (four were measured during the first quarter, one (the maximum) during the second, two during the third, and seven during the fourth).

- Concentrations of carbon tetrachloride measured at ASKY range from 0.132 µg/m^3 to 0.820 µg/m^3, although few measurements fall outside the 0.50 µg/m^3 to 0.75 µg/m^3 range. The six concentrations greater than 0.75 µg/m^3 were all measured at ASKY in 2016, with four measured during the second quarter of the year, including three back-to-back sample days in May, explaining the slightly higher quarterly average for this calendar quarter.

- A few non-detects of 1,3-butadiene and 1,2-dichloroethane were measured at ASKY. For 1,3-butadiene, the annual average concentration for 2015 is the same as the annual average for 2016 (0.06 ± 0.01 µg/m^3), although the quarterly average concentrations exhibit slightly more variability in 2016. The annual averages of 1,2-dichloroethane for each year are also similar to each other.

- Quarterly and annual averages for hexachloro-1,3-butadiene for 2015 are not presented in Table 12-4 due to the use of a contaminated internal standard at the laboratory for Method TO-15, which resulted in the invalidation of the results from early March 2015 through mid-December 2015, as described in Section 2.4. For 2016, the quarterly average concentrations vary little across the calendar quarters. Note that none of the 17 measured detections of hexachloro-1,3-butadiene measured at ASKY were greater than the MDL for this pollutant.

- Table 4-10 presents the NMP sites with the 10 highest annual average concentrations for each of the program-level VOC pollutants of interest. ASKY does not appear on this list.

- Each of the five metal pollutants of interest for ASKY-M were detected in all of the valid samples collected at this site in 2015 and 2016.

- The pollutant of interest with the highest annual average concentrations for ASKY-M is manganese (25.05 ± 5.70 ng/m^3 for 2015 and 19.85 ± 4.75 ng/m^3 for 2016), followed by lead (8.83 ± 2.08 ng/m^3 for 2015 and 6.97 ± 1.86 ng/m^3 for 2016) and nickel (2.20 ± 0.49 ng/m^3 for 2015 and 2.12 ± 0.62 ng/m^3 for 2016).

- Concentrations of manganese measured at ASKY-M range from 1.49 ng/m^3 to 117 ng/m^3, which is the second highest manganese concentration measured across the program. Manganese concentrations greater than 50 ng/m^3 were measured at four NMP sites sampling PM_{10} metals, with measurements from ASKY-M accounting for most of them (10 out of 14). Nine of these 10 manganese concentrations were measured at ASKY-M during the first and second calendar quarters; five were measured in 2015, three in March and two in May (including the maximum concentration) and four were measured in 2016, but these were more spread out across the months of the first and second quarters.

- Concentrations of lead measured at ASKY-M range from 0.640 ng/m^3 to 41.4 ng/m^3, which is the second highest lead concentration measured across the program. The maximum lead concentration was also measured at ASKY-M during May 2015, but on a different sample day than the highest manganese concentration was measured. Concentrations of lead measured at ASKY-M account for six of the 10 lead measurements greater than 20 ng/m^3 measured at NMP sites sampling PM_{10} metals; ASKY-M is the only NMP site at which more than one was measured.

- Concentrations of arsenic measured at ASKY-M range from 0.153 ng/m^3 to 7.36 ng/m^3. The maximum arsenic concentration measured at ASKY-M is the maximum arsenic concentration measured across the program. This concentration was measured on May 24, 2015, the same day that the highest manganese concentration was measured at ASKY-M. This explains, at least in part, the relatively large confidence interval shown in Table 12-4 for the second quarter average of 2015. This is also the calendar quarter in which the most arsenic concentrations greater than 2 ng/m^3 were measured (5). ASKY-M has the highest number of arsenic measurements greater than 2 ng/m^3 compared to any other NMP site (16, which is twice the site(s) with next highest, for which BAKY and BTUT are tied).

- Concentrations of cadmium measured at ASKY-M range from 0.032 ng/m^3 to 5.99 ng/m^3. The maximum cadmium concentration measured at ASKY-M is the maximum cadmium concentration measured across the program. This concentration is more than three times higher than the next highest concentration measured at ASKY-M (1.75 ng/m^3); this concentration was measured on January 25, 2016 and the effects of this outlier can be seen in the first quarter average concentration for 2016 as the associated confidence interval is greater than the average itself. Of the 10 cadmium concentrations greater than 1 ng/m^3 measured across the program, half were measured at ASKY-M.

- Quarterly average concentrations for the third quarter of 2016 could not be calculated because there were too many invalid samples during this calendar quarter.

- Table 4-13 presents the NMP sites with the 10 highest annual average concentrations for the program-level metal pollutant of interest (arsenic). This table shows that the highest annual average concentrations for arsenic were calculated for ASKY-M (2015, followed by 2016). Similar observations were made in the 2013 and 2014 NMP reports. ASKY-M has the only annual average concentrations of arsenic greater than 1 ng/m^3 (1.38 ± 0.32 ng/m^3 for 2015 and 1.13 ± 0.23 ng/m^3 for 2016).

Observations for GLKY from Table 12-4 include the following:

- GLKY sampled VOCs, carbonyl compounds, metals (PM_{10}), and PAHs.

- The only pollutant of interest for GLKY with an annual average concentration greater than 1 µg/m^3 is formaldehyde (1.76 ± 0.25 µg/m^3 for 2015 and 1.87 ± 0.24 µg/m^3 for 2016). However, these are among some of the lowest annual averages of formaldehyde calculated among NMP sites sampling carbonyl compounds. The annual average concentrations of formaldehyde also exhibit the largest year-to-year difference; the annual average concentrations for each of the other pollutants of interest for GLKY vary by 0.01 µg/m^3 or less between the two years of sampling.

- Concentrations of formaldehyde measured at GLKY range from 0.446 µg/m^3 to 5.43 µg/m^3. The highest formaldehyde concentration for each year was measured on the same day, June 11th. Concentrations of formaldehyde were higher during the warmer months of 2015, based on the quarterly averages. This is mostly true for 2016, although a few higher concentrations were measured in October and November 2016. The 31 formaldehyde concentrations greater than 2.50 µg/m^3 measured at GLKY were split nearly evenly across the two years of sampling. For 2015, all 16 of these concentrations were measured during the second or third quarters of the year. For 2016, 12 of these concentrations were measured during the second or third quarters of the year, with the other three measured on back-to-back sample days during the fourth quarter.

- Concentrations of acetaldehyde measured at GLKY range from 0.271 µg/m^3 to 2.55 µg/m^3. Acetaldehyde concentrations greater than 1 µg/m^3 were not measured at GLKY for a nine-month stretch between August 2015 and March 2016, which is reflected in the quarterly average concentrations shown for this pollutant.

- Among the VOC pollutants of interest for GLKY, carbon tetrachloride has the highest annual average concentrations. The quarterly average concentrations of carbon tetrachloride exhibit little variability across the two years of sampling, varying by less than 0.1 µg/m^3. Concentrations of carbon tetrachloride measured at GLKY range from 0.182 µg/m^3 to 0.820 µg/m^3, with only a few measurements falling outside the 0.50 µg/m^3 to 0.75 µg/m^3 range.

- Based on the quarterly average concentrations shown, benzene concentrations appear higher during the colder months of the year. Concentrations of benzene measured at GLKY range from 0.128 µg/m^3 to 1.14 µg/m^3, with no concentrations greater than 0.5 µg/m^3 measured outside the first or fourth quarters of either year.

- All of GLKY's 1,3-butadiene concentrations are less than 0.1 µg/m^3; GLKY is one of three NMP sites sampling 1,3-butadiene with Method TO-15 for which this is true. There is little variability in the quarterly average concentrations shown for this pollutant.

- All but one of GLKY's 1,2-dichloroethane concentrations are also less than 0.1 µg/m^3. Twelve non-detects of 1,2-dichloroethane were measured at GLKY, two in 2015 and 10 in 2016. The two non-detects in 2015 were measured in August and September; seven of the 10 non-detects in 2016 were also measured in August and September (with one measured during each month during the fourth quarter). These non-detects are reflecting the quarterly average concentrations shown in Table 12-4.

- Arsenic is the only other pollutant of interest for GLKY that is not a VOC or carbonyl compound. Concentrations of arsenic measured at GLKY range from 0.099 ng/m^3 to 2.35 ng/m^3, plus one non-detect. For both years, the third quarter has the highest quarterly average concentration (although the differences are not statistically significant). The maximum arsenic concentration was measured during the third quarter of each year. In addition, the third quarter is the only calendar quarter for each year with a median arsenic concentration greater than 0.5 ng/m^3.

- GLKY is not listed in Tables 4-10 through 4-13, which present the NMP sites with the highest annual average concentrations for each of the program-level pollutants of interest. The annual average concentrations for GLKY's pollutants of interest are among some of the lowest across the program. Only one NMP site has an annual average benzene concentration less than GLKY's.

Observations for BAKY from Table 12-4 include the following:

- Speciated metals were sampled for at BAKY; only arsenic was identified as a pollutant of interest for BAKY.

- Arsenic was measured in all 114 valid metals samples collected at BAKY.

- Arsenic concentrations measured at BAKY range from 0.008 ng/m^3 to 3.15 ng/m^3, which was measured on July 5, 2015. The COC for this sample indicated fireworks during sampling. The four highest arsenic concentrations were measured at BAKY in 2015, with three of the four measured during the third quarter. The third quarter average concentration is the highest quarterly average for each year, although there is considerable variability in the arsenic concentrations measured each quarter. Half of the 18 arsenic concentrations greater than 1 ng/m^3 measured at BAKY in 2015 were measured during the third quarter; nearly half (10) of the 22 arsenic concentrations greater than 1 ng/m^3 in 2016 were measured during the third quarter.

- Among NMP sites sampling PM_{10} metals, BAKY has the third (2015) and fifth (2016) highest annual average concentrations of arsenic, behind only ASKY-M (which ranks first and second) and NBIL (which ranks fourth), as shown in Table 4-13. Similar observations were made in the 2014 and 2013 NMP reports.

Observations for the Calvert City monitoring sites from Table 12-4 include the following:

- VOC samples were collected at all three Calvert City sites (ATKY, BLKY, and TVKY); PM_{10} metals were also sampled for at BLKY.

- Benzene, carbon tetrachloride, 1,2-dichloroethane, 1,3-butadiene, and vinyl chloride were identified as pollutants of interest for all three Calvert City sites. These sites are the only NMP sites with vinyl chloride as a pollutant of interest.

- Some of the highest concentrations of VOCs were measured at the Calvert City sites and these data are reviewed in the bullets that follow.

- When detected, vinyl chloride is generally measured at relatively low levels under the NMP. Across the program, this pollutant was detected in 32 percent of the total samples collected, and of these, two-thirds were less than the MDL. Together, the Calvert City sites account for 278 of the 914 measured detections of this pollutant. The Calvert City sites account for all 146 concentrations of vinyl chloride greater than 0.15 $\mu g/m^3$ measured across the program, including the 39 measurements greater than 1 $\mu g/m^3$. The seven highest concentrations of vinyl chloride across the program were measured at ATKY, with these measurements ranging from 3.42 $\mu g/m^3$ to 13.1 $\mu g/m^3$. Twenty-five vinyl chloride concentrations of at least 1 $\mu g/m^3$ were measured at ATKY, with 12 measured at TVKY and two measured at BLKY.

- As shown in Table 12-4, annual average concentrations of vinyl chloride for these three sites range from 0.10 ± 0.04 $\mu g/m^3$ for BLKY in 2015 to 0.83 ± 0.54 $\mu g/m^3$ for ATKY in 2016. The annual average and quarterly average concentrations of vinyl chloride for these sites have relatively large confidence intervals, including several that are larger than the average itself (such as ATKY's fourth quarter average for 2015, 0.58 ± 0.87 $\mu g/m^3$). This is indicative of the large amount of variability associated with these measurements.

- Another pollutant for which the highest concentrations program-wide were measured at the Calvert City sites is 1,2-dichloroethane. The 174 highest concentrations of 1,2-dichloroethane across the program were measured at the Calvert City sites. This includes all 100 measurements greater than 1 $\mu g/m^3$ and 22 greater than 10 $\mu g/m^3$.

- Annual average concentrations of 1,2-dichloroethane for these sites range from 0.41 ± 0.19 $\mu g/m^3$ for ATKY (2015) to 3.75 ± 1.56 $\mu g/m^3$ for TVKY (2015). Each of the Calvert City sites has at least two quarterly average concentrations of 1,2-dichloroethane greater than 1 $\mu g/m^3$; in the case of TVKY, all of the quarterly averages are greater than 1 $\mu g/m^3$ and include one greater than 5 $\mu g/m^3$. Nearly all the quarterly and annual averages have a relatively large confidence interval associated with them, some greater than the average itself, indicating the relatively large amount of variability associated with these measurements.

- The highest measurements of carbon tetrachloride across the program were also measured at the Calvert City sites. All 22 carbon tetrachloride concentrations greater than or equal to 1 $\mu g/m^3$ measured across the program were measured at the Calvert City sites (12 measured at TVKY, eight at BLKY, and two at ATKY). All five carbon tetrachloride concentrations greater than 2 $\mu g/m^3$ were measured at TVKY.

- Annual average concentrations of carbon tetrachloride for the Calvert City sites range from 0.67 ± 0.03 $\mu g/m^3$ for ATKY and BLKY (2015) to 0.85 ± 0.13 $\mu g/m^3$ for TVKY (2015). Quarterly average concentrations for TVKY exhibit the most variability, ranging from 0.70 ± 0.04 $\mu g/m^3$ for the second quarter of 2015 to 0.94 ± 0.42 $\mu g/m^3$ for the third quarter of 2015. Most of the quarterly average concentrations calculated for NMP sites sampling carbon tetrachloride fall between 0.55 $\mu g/m^3$ and 0.75 $\mu g/m^3$; five of TVKY's quarterly averages and two of BLKY's quarterly averages are outside this range.

- Nine of the 10 1,3-butadiene concentrations greater than 1 $\mu g/m^3$ measured across the program were measured at TVKY. Concentrations of 1,3-butadiene greater than 0.5 $\mu g/m^3$ were measured at only five NMP sites in 2015 and 2016; concentrations measured at TVKY account for 15 of these 41 concentrations (tying with PXSS for the most). A single measurement greater than 0.5 $\mu g/m^3$ was measured at BLKY. Annual average concentrations of 1,3-butadiene for the Calvert City sites range from 0.05 ± 0.01 $\mu g/m^3$ for ATKY (2016) to 0.35 ± 0.19 $\mu g/m^3$ for TVKY (2015).

- Quarterly average concentrations of 1,3-butadiene for TVKY exhibit considerable variability, ranging from 0.05 ± 0.05 $\mu g/m^3$ for the third quarter of 2016 to 0.44 ± 0.38 $\mu g/m^3$ for the first quarter of 2015. Many of the quarterly average concentrations for TVKY have relatively large confidence intervals associated with them, several of which are equivalent to or greater than the average itself.

- Benzene is the only other VOC that is a pollutant of interest across the Calvert City sites. The maximum benzene concentration measured across the program (6.85 $\mu g/m^3$) was measured at ATKY on October 9, 2015. Concentrations measured at ATKY and TVKY account for seven of the 10 benzene measurements greater than 4 $\mu g/m^3$ measured across the program. These seven concentrations were all measured in 2015. Most of the benzene concentrations greater than 1 $\mu g/m^3$ measured at these two sites were measured in 2015 (30 out of 38). The quarterly and annual average concentrations of benzene for ATKY and TVKY reflect this; for both sites, the annual average concentration for 2015 is roughly twice the annual average for 2016 (for example, TVKY's annual average benzene concentration for 2015 is 1.04 ± 0.30 $\mu g/m^3$, compared to TVKY's annual average of 0.54 ± 0.09 $\mu g/m^3$ for 2016). The difference in the magnitude of benzene concentrations between the two years of sampling is much less at BLKY.

- Hexachloro-1,3-butadiene is a pollutant of interest for ATKY and BLKY. Quarterly and annual averages for hexachloro-1,3-butadiene for 2015 are not presented in Table 12-4 due to the use of a contaminated internal standard at the laboratory for Method TO-15, which resulted in the invalidation of measurements from early March 2015 through mid-December 2015, as described in Section 2.4. The maximum concentration of hexachloro-1,3-butadiene measured at BLKY (0.15 $\mu g/m^3$) ties with

the same concentration measured at five other sites (including TVKY) as the second highest concentration of this pollutant across the program. However, even this measurement is less than the MDL (only one concentration measured over the two-year sampling period is greater than the MDL for hexachloro-1,3-butadiene).

- 1,1,2-Trichloroethane is a pollutant of interest for ATKY and TVKY, the only NMP sites for which this is true. This pollutant was detected in 88 samples collected across the program in 2015 and 2016, with measurements from the Calvert City sites accounting for 58 of them. This pollutant was detected 29 times at TVKY, 15 times at ATKY, and 14 times at BLKY. TVKY, ATKY, and BLKY account for all 32 concentrations of this pollutant greater than 0.1 $\mu g/m^3$, including four greater than 1 $\mu g/m^3$ and one greater than 2 $\mu g/m^3$ (all of which were measured in 2016). This pollutant was still detected infrequently at these sites, though, and in some cases, was not detected at every site during some calendar quarters. Combining many zeros substituted for non-detects with a few relatively high measurements, results in quarterly and annual averages exhibiting large confidence intervals, such as ATKY and TVKY's 2016 annual averages, both 0.09 ± 0.08 $\mu g/m^3$.

- Table 4-10 presents the NMP sites with the 10 highest annual average concentrations for each of the program-level VOC pollutants of interest. The Calvert City sites appear in Table 4-10 17 times. Both years' annual averages for the three Calvert City sites appear in Table 4-10 for carbon tetrachloride and 1,2-dichloroethane, with the averages for TVKY ranking highest for each pollutant. TVKY also has the highest (2015) and sixth highest (2016) annual average concentrations of 1,3-butadiene across the program. TVKY also has the tenth highest annual average benzene concentration (2015) among sites sampling this pollutant. BLKY and ATKY's 2016 annual average concentrations of hexachloro-1,3-butadiene rank fifth and eighth highest, respectively, among NMP sites sampling this pollutant.

- Metals (PM_{10}) were also sampled for at BLKY; arsenic is the only non-VOC pollutant of interest for BLKY. Concentrations of arsenic measured at BLKY range from 0.018 ng/m^3 to 1.62 ng/m^3, plus one non-detect. BLKY's annual average arsenic concentration for 2015 (0.57 ± 0.09 $\mu g/m^3$) is similar to this site's 2016 annual average (0.54 ± 0.07 $\mu g/m^3$).

Observations for LEKY from Table 12-4 include the following:

- VOC and speciated metals samples were collected at LEKY in 2015 and 2016, although VOC sampling was discontinued at the end of July 2016.

- Based on the available quarterly and annual average concentrations available for LEKY, the pollutant of interest with the highest concentrations is carbon tetrachloride. Concentrations of carbon tetrachloride measured at LEKY range from 0.473 $\mu g/m^3$ to 0.832 $\mu g/m^3$, with only a few measurements outside the 0.50 $\mu g/m^3$ to 0.75 $\mu g/m^3$ range. Five of the six carbon tetrachloride concentrations greater than 0.75 $\mu g/m^3$ were measured in 2016, explaining, at least in part, the higher quarterly average concentrations shown for 2016 compared to those for 2015. At the other end of the concentration scale, a greater number of concentrations less than 0.6 $\mu g/m^3$ were measured in 2015 (17) compared to 2016 (one), further explaining the lower

quarterly average concentrations for 2015 compared to 2016. However, a full year's worth of data for 2016 may result in different findings.

- Although LEKY's quarterly and annual average concentrations of carbon tetrachloride are higher in magnitude, quarterly and annual average concentrations of benzene exhibit more variability, based on both the range of averages and the confidence intervals shown. Benzene concentrations measured at LEKY range from 0.182 µg/m^3 to 1.10 µg/m^3. Few NMP sites have a quarterly average concentration of benzene less than LEKY's second quarter average for 2016 (0.35 ± 0.06 µg/m^3). A review of the data shows that this calendar quarter is the only one without a benzene concentration greater than 0.6 µg/m^3 (all others have at least two, with the number ranging from two to six). In addition, the only two benzene concentrations less than 0.2 µg/m^3 were also measured during this calendar quarter.

- Concentrations of arsenic measured at LEKY range from 0.150 ng/m^3 to 4.97 ng/m^3, which is the fifth highest arsenic concentration measured across the program. The fourth quarter average concentration for 2015 is the only quarterly average greater than 1 ng/m^3 (1.06 ± 0.60 ng/m^3) and has a relatively large confidence interval associated with it. This is attributable to the maximum arsenic concentration, which was measured at LEKY during the fourth quarter of 2015, and is more than three times greater than the next highest concentration measured during this calendar quarter. Among NMP sites sampling PM_{10} metals, LEKY has the ninth highest annual average concentration of arsenic (0.81 ± 0.13 ng/m^3, 2015), as shown in Table 4-13. An annual average for 2016 is not provided because the completeness criteria specified in Section 2.4 was not met. A number of metals samples were invalid throughout 2016, including a series of samples collected at LEKY in March and April 2016 with QA-related issues.

12.3.2 Concentration Comparison

In order to better illustrate how each site's annual average concentrations compare to the program-level averages, a site-specific box plot was created for each of the site-specific pollutants of interest, where annual averages are available. Thus, box plots were created for each of the pollutants listed in Table 12-4 for the Kentucky sites. Figures 12-14 through 12-28 overlay the sites' minimum, annual average, and maximum concentrations for each year onto the program-level minimum, first quartile, median, average, third quartile, and maximum concentrations, as described in Section 3.4.2.1. If an annual average concentration could not be calculated, the range of concentrations is still provided in the figures that follow.

Figure 12-14. Program vs. Site-Specific Average Acetaldehyde Concentrations

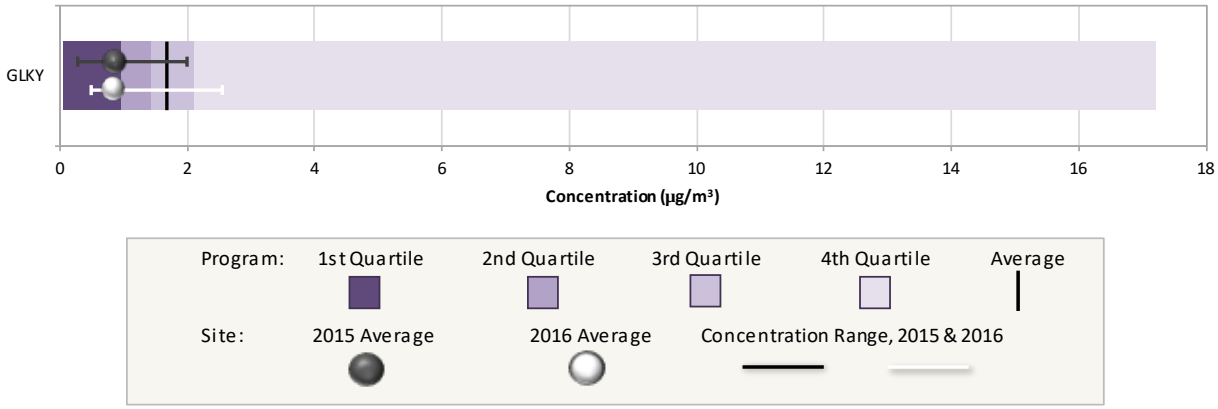


Figure 12-14 presents the box plot for acetaldehyde for GLKY and shows the following:

- The range of acetaldehyde concentrations measured at GLKY is relatively small, particularly for 2015, when all of the measurements are less than 2 µg/m^3 (and the program-level third quartile).

- Both annual average concentrations for GLKY are less than the program-level first quartile (0.96 µg/m^3).

Figure 12-15. Program vs. Site-Specific Average Arsenic (PM_{10}) Concentrations

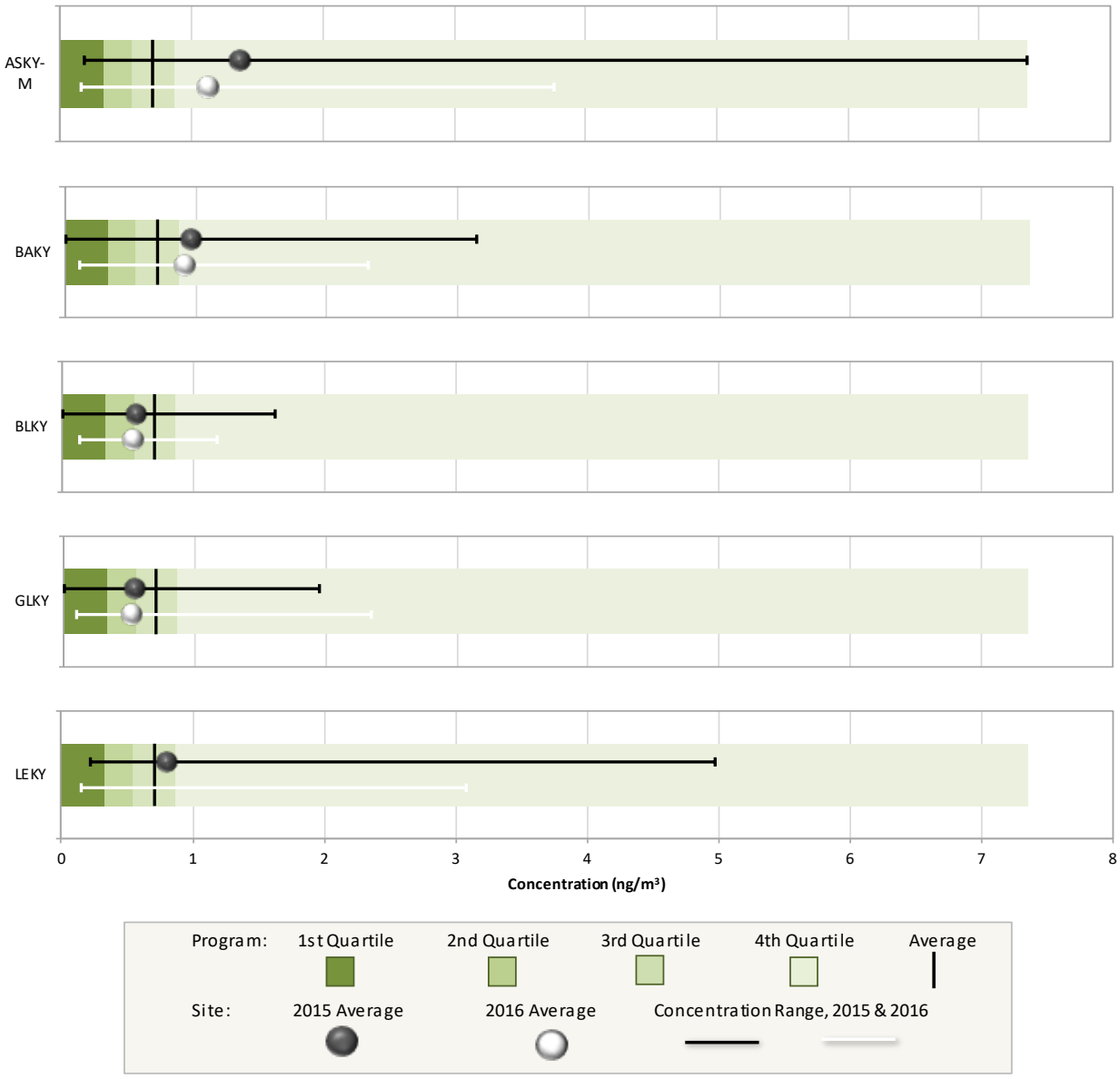


Figure 12-15 presents the box plots for arsenic for the five Kentucky sites sampling PM_{10} metals and shows the following:

- Among the Kentucky sites, the range of arsenic concentrations measured is smallest for BLKY and largest for ASKY-M. Several of the highest arsenic concentrations measured across the program were measured at Kentucky sites, including the program-level maximum arsenic concentration (7.36 ng/m^3), which was measured at ASKY-M in 2015.

- The annual average concentrations of arsenic for ASKY-M, BAKY, and LEKY (2015) are greater than the program-level average concentration while the annual average concentrations for BLKY and GLKY are less than the program-level average

concentration. The annual average concentrations for ASYK-M and BAKY are also greater than the program-level third quartile.

- Two non-detects of arsenic were measured, one each at BLKY and GLKY. While it appears that a non-detect was also measured at BAKY, the minimum arsenic concentration measured at BAKY is 0.008 ng/m^3, the second lowest measured detection of arsenic measured across the program. Two of the three arsenic concentrations less than 0.01 ng/m^3 measured across the program were measured at BAKY.

Figure 12-16. Program vs. Site-Specific Average Benzene Concentrations

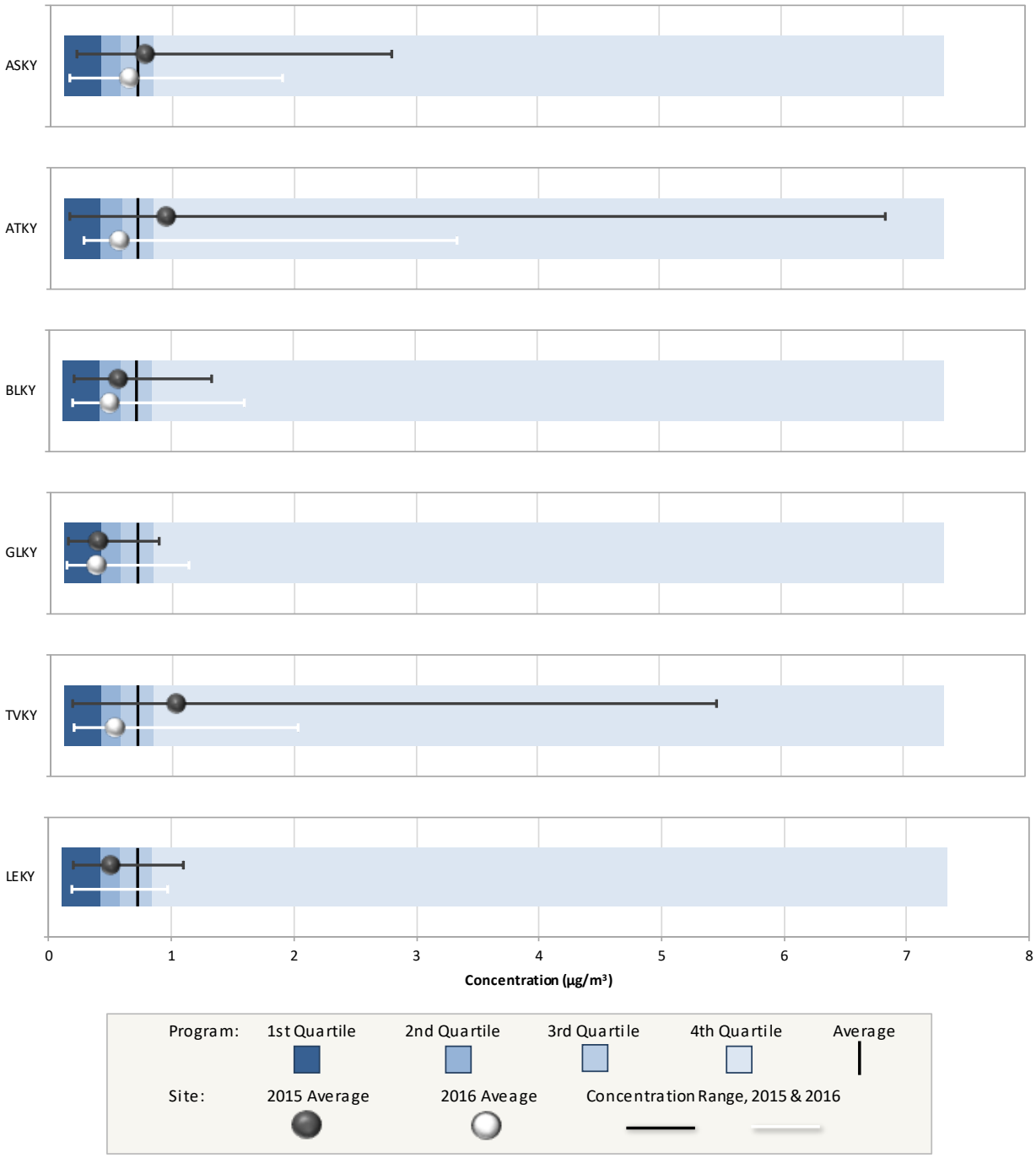


Figure 12-16 presents the box plots for benzene for the six Kentucky sites sampling VOCs and shows the following:

- The box plots show that the range of benzene concentrations measured is smallest for GLKY and LEKY and largest for TVKY and ATKY, particularly for 2015. The range of benzene concentrations measured at TVKY and ATKY in 2016 is considerably smaller than the range measured in 2015. This is also true for ASKY, and to a lesser extent, LEKY (although 2016 does not include a full year's worth of sampling).

- The annual average concentrations of benzene across the Kentucky sites range from 0.39 ± 0.04 µg/m^3 (GLKY for both years) to 1.04 ± 0.30 µg/m^3 (TVKY, 2015). The 2015 annual averages for ASKY, ATKY, and TVKY are greater than the program-level average concentration (0.72 µg/m^3), while their 2016 annual averages are less than the program-level average. The annual average concentrations of benzene for GLKY are less than the annual averages calculated for the other Kentucky sites and less than the program-level first quartile (0.42 µg/m^3).

Figure 12-17. Program vs. Site-Specific Average 1,3-Butadiene Concentrations

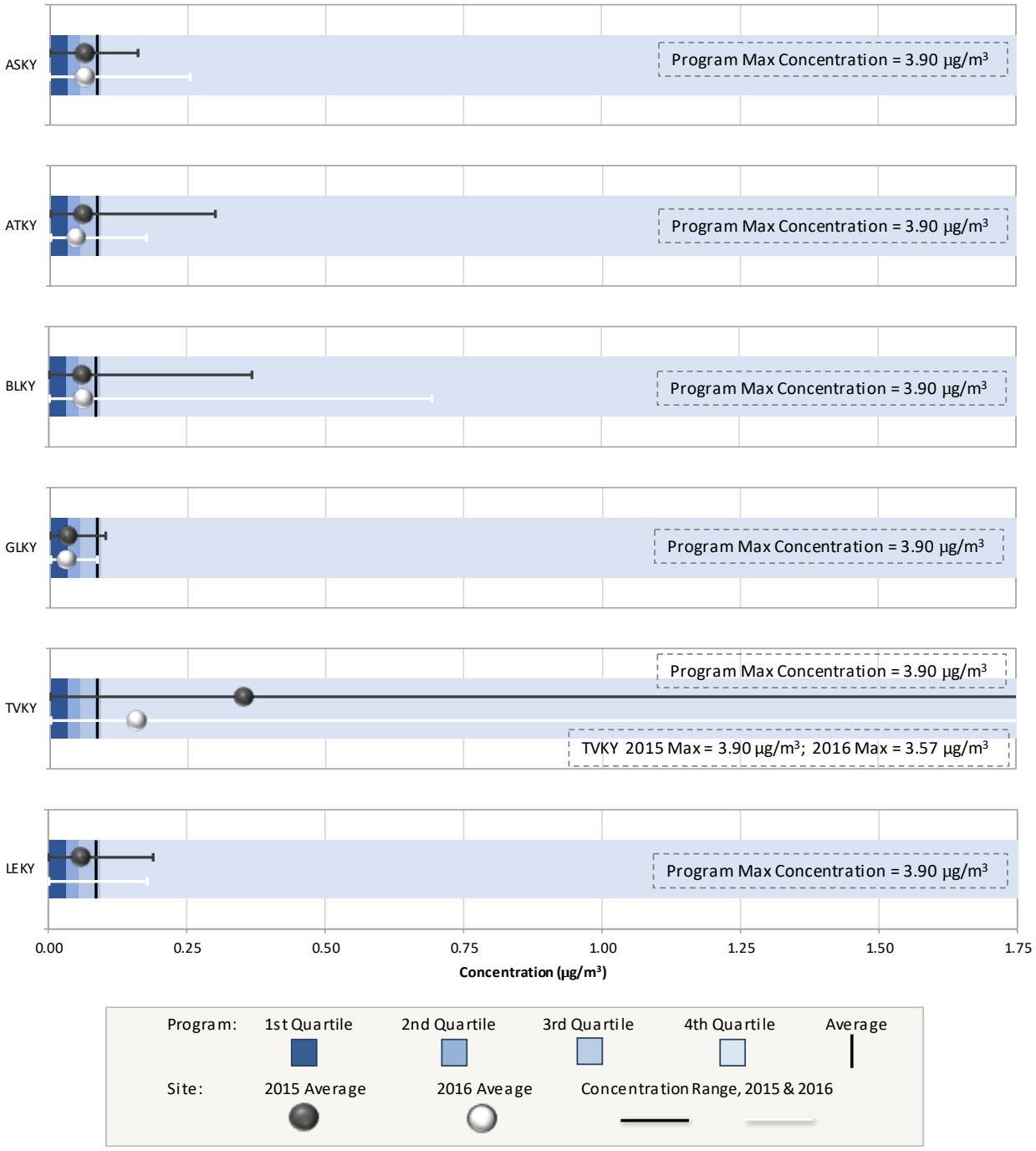


Figure 12-17 presents the box plots for 1,3-butadiene for the six Kentucky sites sampling VOCs and shows the following:

- The program-level maximum concentration (3.90 µg/m^3) is not shown directly on the box plots because the scale of the box plots would be too large to readily observe data points at the lower end of the concentration range. Thus, the scale of the box plots has been reduced to 1.75 µg/m^3. Also, since the maximum 1,3-butadiene concentration

measured each year at TVKY is greater than the scale of the box plots, the site-specific maximum concentrations are labeled for this site.

- The maximum 1,3-butadiene concentration measured across the program was measured at TVKY in 2015, although the maximum concentration measured at this site in 2016 is similar in magnitude. 1,3-Butadiene concentrations greater than 0.75 $\mu g/m^3$ were not measured at the other Kentucky sites; BLKY is the only other Kentucky site at which 1,3-butadiene concentrations greater than 0.3 $\mu g/m^3$ were measured.

- TVKY is the only Kentucky site for which an annual average concentration of 1,3-butadiene greater than the program-level average concentration (0.09 $\mu g/m^3$) was calculated. Although TVKY's annual average for 2015 is twice the annual average for 2016, both are still greater than the program-level average concentration.

- The annual average concentrations for the remaining sites vary little, ranging from 0.03 ± 0.14 $\mu g/m^3$ for GLKY (both years) to 0.06 ± 0.03 $\mu g/m^3$ for BLKY (2016).

- The program-level average concentration is similar to the third quartile, indicating that the 1,3-butadiene concentrations on the upper end of the concentration range are driving the program-level average upward.

- Non-detects of 1,3-butadiene were measured at each of the Kentucky sites. Among the five sites sampling VOC for two full years, the number of non-detects was highest for GLKY (23) and lowest for ASKY (9).

Figure 12-18. Program vs. Site-Specific Average Cadmium (PM_{10}) Concentrations

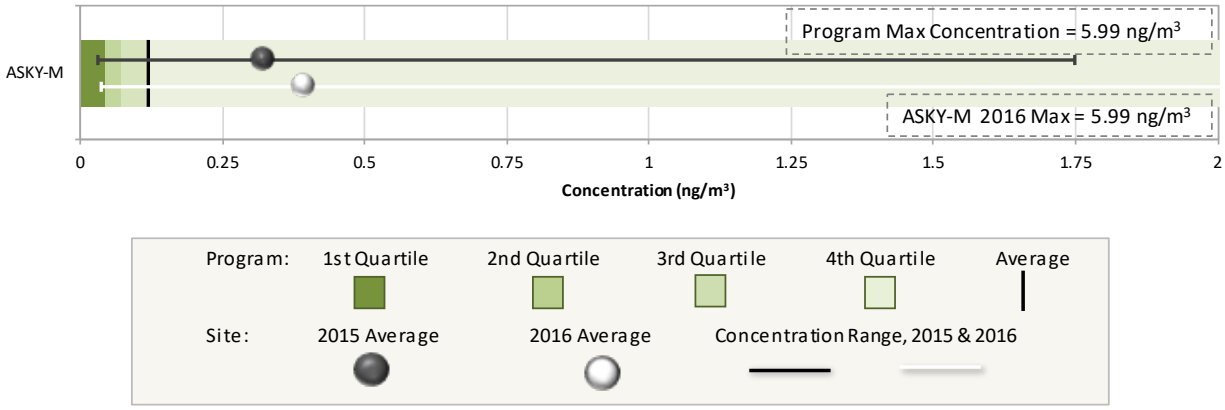


Figure 12-18 presents the box plot for cadmium for ASKY-M and shows the following:

- Similar to 1,3-butadiene, the program-level maximum cadmium concentration (5.99 ng/m^3) is not shown directly on the box plot as the scale of the box plot has been reduced to 2 ng/m^3 in order to allow for the observation of data points at the lower end of the concentration range.

- ASKY-M is one of only two NMP sites sampling PM_{10} metals for which cadmium is a pollutant of interest.

- The maximum concentration measured at ASKY-M in 2016 is the maximum concentration measured across the program. Although the maximum cadmium concentration measured at this site in 2015 is one-third the magnitude, it is still one of the higher measurements among NMP sites sampling metals (seventh highest).

- ASKY-M's annual average concentration of cadmium for 2016 is more than three times greater than the program-level average concentration (0.12 ng/m^3) while ASKY-M's annual average concentration of cadmium for 2015 is slightly less.

- The program-level average cadmium concentration is similar to the third quartile, indicating that cadmium concentrations on the upper end of the concentration range are driving the program-level average upward.

Figure 12-19. Program vs. Site-Specific Average Carbon Tetrachloride Concentrations

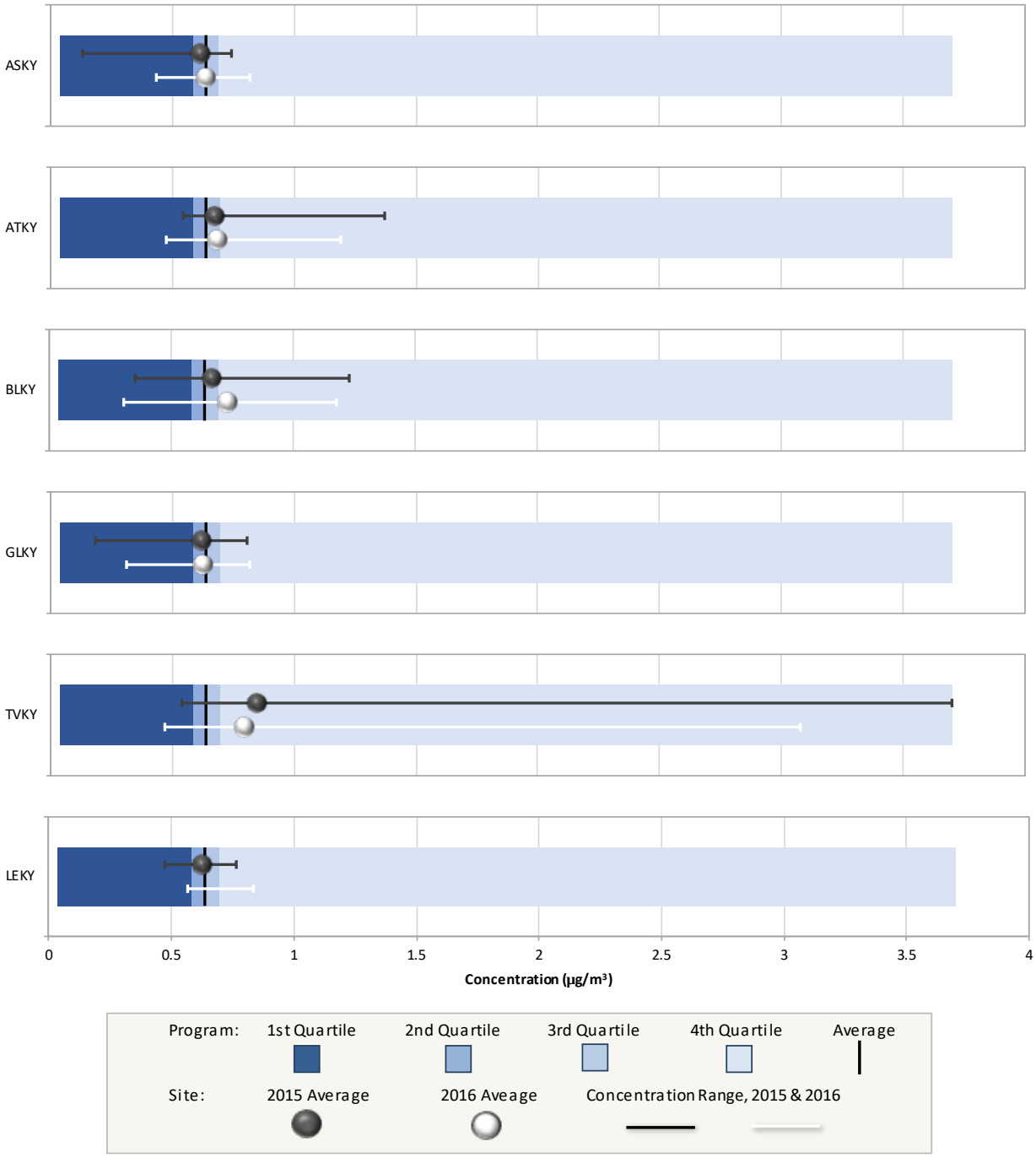


Figure 12-19 presents the box plots for carbon tetrachloride for the six Kentucky sites sampling VOCs and shows the following:

- Approximately 0.11 µg/m^3 separates the first and third quartiles, indicating that roughly 50 percent of the concentrations of carbon tetrachloride measured in 2015 and 2016 fall into a fairly tight range of measurements. The program-level median and average concentrations are similar to each other (both approximately 0.64 µg/m^3) and plotted on top of each other.

- The range of carbon tetrachloride measurements was largest for TVKY and smallest for LEKY. The six highest carbon tetrachloride concentrations measured across the program were measured at TVKY, although concentrations greater than 1 µg/m^3 were also measured at BLKY and ATKY.

- The annual average concentrations of carbon tetrachloride for the three Calvert City sites are greater than the program-level average (0.64 µg/m^3) and each of these sites has at least one annual average greater than or similar to the program-level third quartile (0.69 µg/m^3). For the remaining Kentucky sites sampling carbon tetrachloride, the annual average concentrations vary by less than 0.025 µg/m^3.

- Across the program, most annual average concentrations of carbon tetrachloride do not vary by more than 0.1 µg/m^3, generally falling between 0.6 µg/m^3 and 0.7 µg/m^3. BLKY and TVKY are the only sites with annual averages greater than 0.7 µg/m^3 and only TVKY has an annual average greater than 0.8 µg/m^3.

Figure 12-20. Program vs. Site-Specific Average *p*-Dichlorobenzene Concentrations

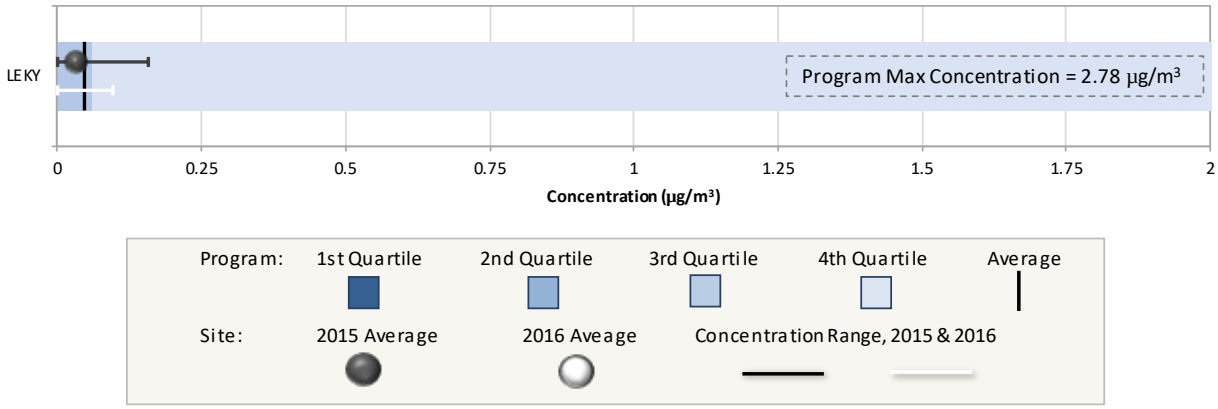


Figure 12-20 presents the box plot for *p*-dichlorobenzene for LEKY and shows the following:

- Similar to other pollutants, the program-level maximum *p*-dichlorobenzene concentration (2.78 µg/m^3) is not shown directly on the box plot as the scale of the box plot has been reduced to allow for the observation of data points at the lower end of the concentration range. Note that the program-level first and second quartiles are zero for this pollutant, indicating that at least 50 percent of the measurements across the program are non-detects and thus, are not visible on the box plot.

- LEKY is the only site for which *p*-dichlorobenzene was identified as a pollutant of interest.

- The range of *p*-dichlorobenzene concentrations measured at LEKY is fairly small, particularly for 2016, though sampling was discontinued at this site at the end of July. All four *p*-dichlorobenzene concentrations greater than 0.1 µg/m^3 were measured at LEKY in 2015.

- The annual average concentration of *p*-dichlorobenzene for LEKY for 2015 is less than the program-level average of 0.05 µg/m^3.

- Forty-seven non-detects of *p*-dichlorobenzene were measured at LEKY, 27 in 2015 and 20 in 2016.

Figure 12-21. Program vs. Site-Specific Average 1,2-Dichloroethane Concentrations

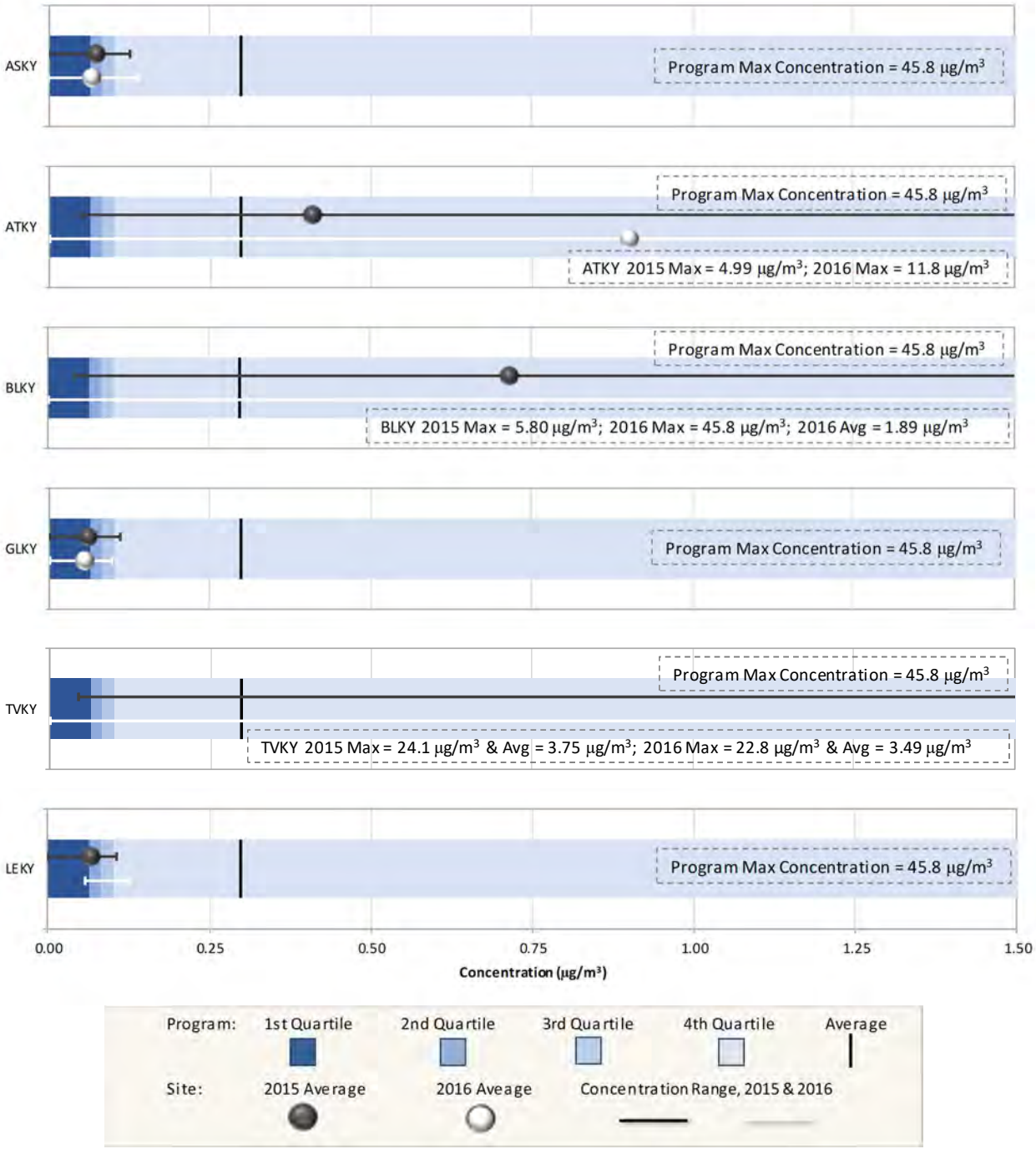


Figure 12-21 presents the box plots for 1,2-dichloroethane for the six Kentucky sites sampling VOCs and shows the following:

- The program-level maximum concentration (45.8 µg/m^3) is not shown directly on the box plots for 1,2-dichloroethane as the scale of the box plots has been reduced to 1.5 µg/m^3 in order to allow for the observation of data points at the lower end of the concentration range. Also, since the maximum 1,2-dichloroethane concentration measured at several sites is greater than the scale of the box plots, the site-specific maximum concentrations are labeled for these sites. Note that the program-level average concentration is nearly three times greater than the third quartile, indicating that the 1,2-dichloroethane concentrations on the upper end of the concentration range are driving the program-level average upward.

- The maximum 1,2-dichloroethane concentrations measured at ASKY, GLKY, and LEKY fall between 0.10 µg/m^3 and 0.15 µg/m^3, similar to many other NMP sites sampling this pollutant. By comparison, the maximum concentration measured at each of the Calvert City sites exceeds, and is often an order of magnitude higher than, the scale of the box plots. The magnitude of some of these measurements is such that even the annual average concentrations exceed the scale of the box plots. These include both of TVKY's annual average concentrations and BLKY's 2016 annual average.

- The annual average concentrations for the Calvert City sites are the highest annual average concentrations of 1,2-dichloroethane among NMP sites sampling VOCs. No other NMP site has an annual average concentration of this pollutant greater than 0.10 µg/m^3; ATKY has the lowest annual average concentration of 1,2-dichloroethane among these three sites (0.41 ± 0.19 µg/m^3), although it is still four times greater than the annual average for the NMP monitoring site with the next highest annual average (TMOK), as shown in Table 4-10.

Figure 12-22. Program vs. Site-Specific Average Formaldehyde Concentrations

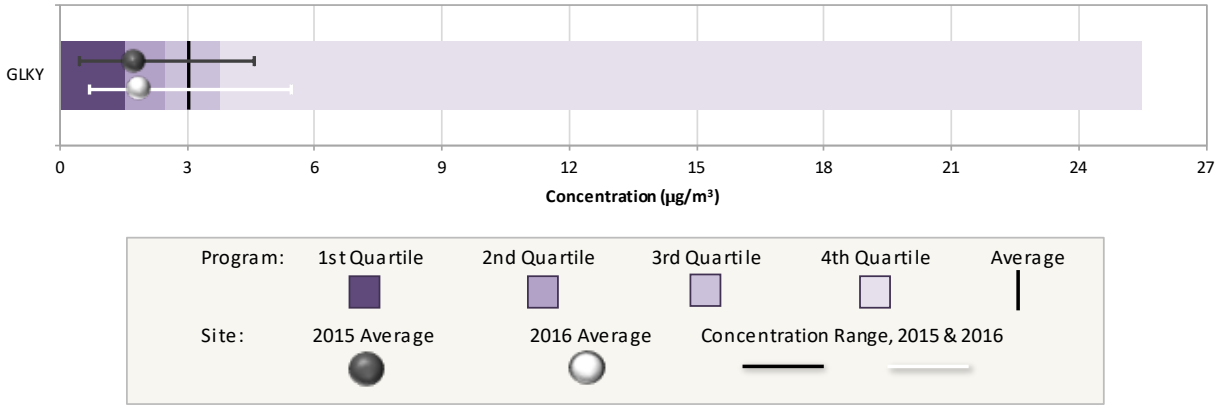


Figure 12-22 presents the box plot for formaldehyde for GLKY and shows the following:

- The maximum formaldehyde concentration measured at GLKY is about one-fifth the maximum formaldehyde concentration measured across the program.

- GLKY's annual averages are both greater than the program-level first quartile (1.54 µg/m^3) but less than the program-level median concentration (2.47 µg/m^3). Eight NMP sites, including GLKY, have at least one annual average concentration of formaldehyde less than 2 µg/m^3.

Figure 12-23. Program vs. Site-Specific Average Hexachloro-1,3-butadiene Concentrations

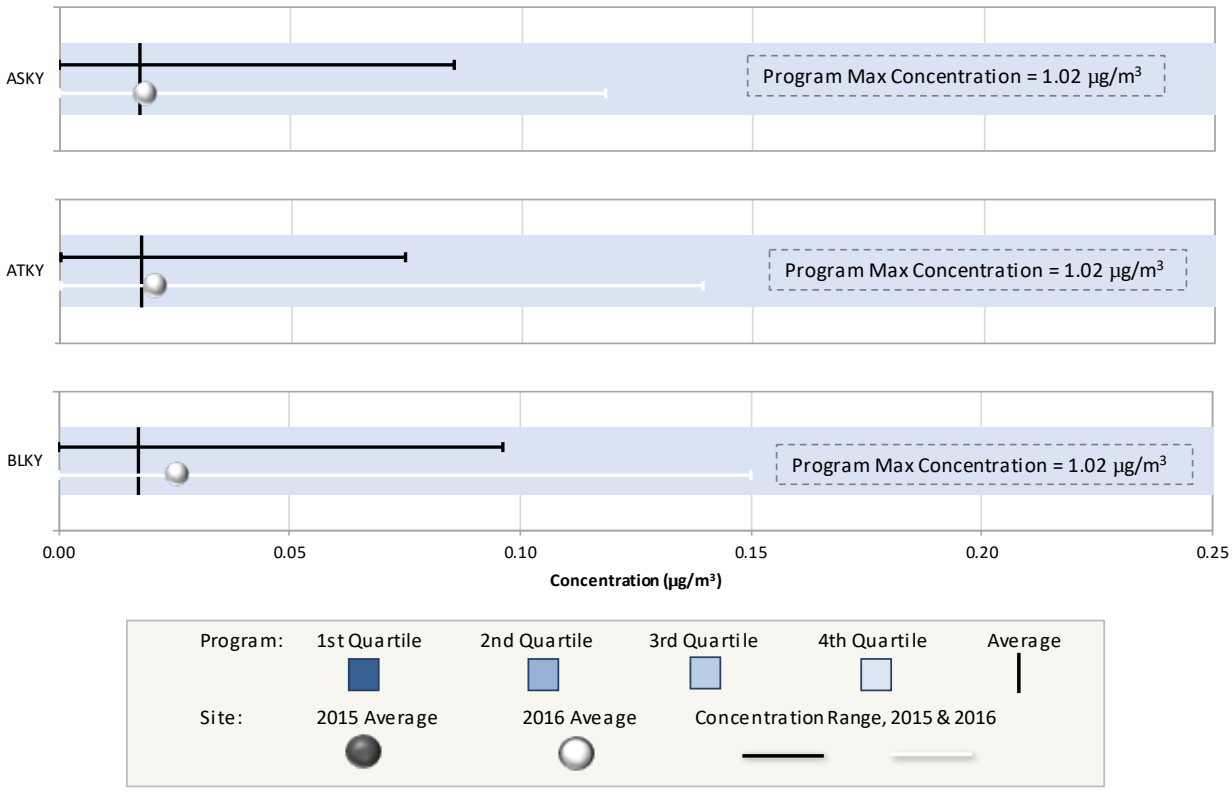


Figure 12-23 presents the box plots for hexachloro-1,3-butadiene for the three Kentucky sites for which this pollutant was identified as a pollutant of interest and shows the following:

- The program-level maximum concentration of hexachloro-1,3-butadiene (1.02 µg/m^3) is not shown directly on the box plots as the scale has been reduced to allow for the observations data points at the lower end of the concentration range. The program-level first, second, and third quartiles are all zero for this pollutant, indicating that at least 75 percent of the measurements across the program are non-detects and thus, are not visible on the box plots.

- Annual average concentrations for hexachloro-1,3-butadiene were not calculated for 2015 due to the use of a contaminated internal standard at the laboratory for Method TO-15, which resulted in the invalidation of the results from early March 2015 through mid-December 2015, as described above and in Section 2.4.

- Hexachloro-1,3-butadiene concentrations greater than 0.15 µg/m^3 were not measured at these sites (or at any other NMP site other than the site where the maximum concentration was measured).

- The number of measured detections of this pollutant for these sites ranged from 17 (ASKY and ATKY) to 23 (BLKY), and thus, hexachloro-1,3-butadiene was detected in fewer than one-third of the valid samples collected at these sites.

- Less than 0.01 µg/m^3 separates the annual average concentrations of hexachloro-1,3-butadiene for these Kentucky shown; however, the annual averages of this pollutant for all NMP sites sampling VOCs vary by less than 0.05 µg/m^3, including two sites at which hexachloro-1,3-butadiene was not detected).

Figure 12-24. Program vs. Site-Specific Average Lead (PM_{10}) Concentrations

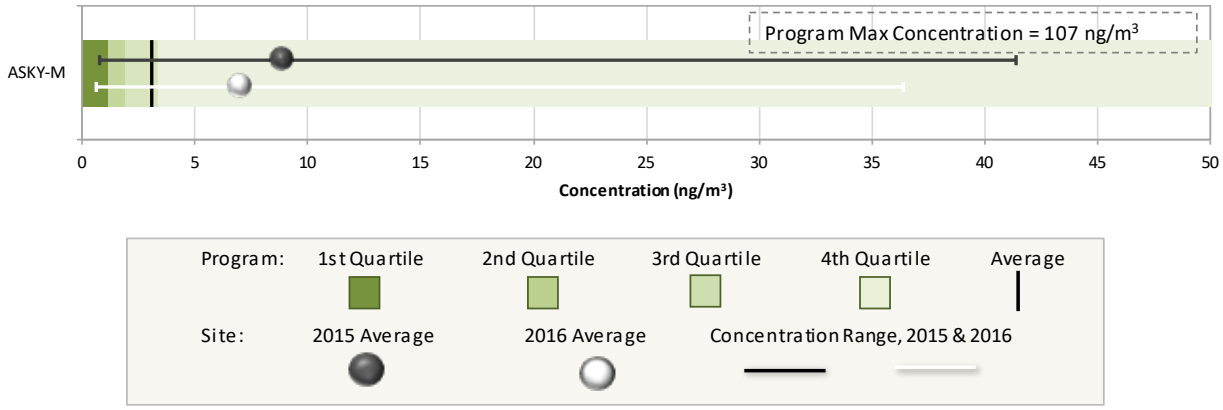


Figure 12-24 presents the box plot for lead for ASKY-M and shows the following:

- The program-level maximum lead concentration (107 ng/m^3) is not shown directly on the box plot as the scale of the box plot has been reduced to allow for the observation of data points at the lower end of the concentration range.

- ASKY-M is the only NMP site for which lead is a pollutant of interest.

- The maximum lead concentration measured at ASKY-M in 2015 (41.4 ng/m^3) is the second highest concentration of lead measured across the program; the maximum concentration measured at ASKY-M in 2016 (36.4 ng/m^3) is the fourth highest lead concentration measured across the program.

- Both of ASKY-M's annual average concentrations of lead are more than two times greater than the program-level average concentration (3.07 ng/m^3), with ASKY-M's annual average concentration for 2016 nearly three times higher than the program-level average.

Figure 12-25. Program vs. Site-Specific Average Manganese (PM_{10}) Concentrations

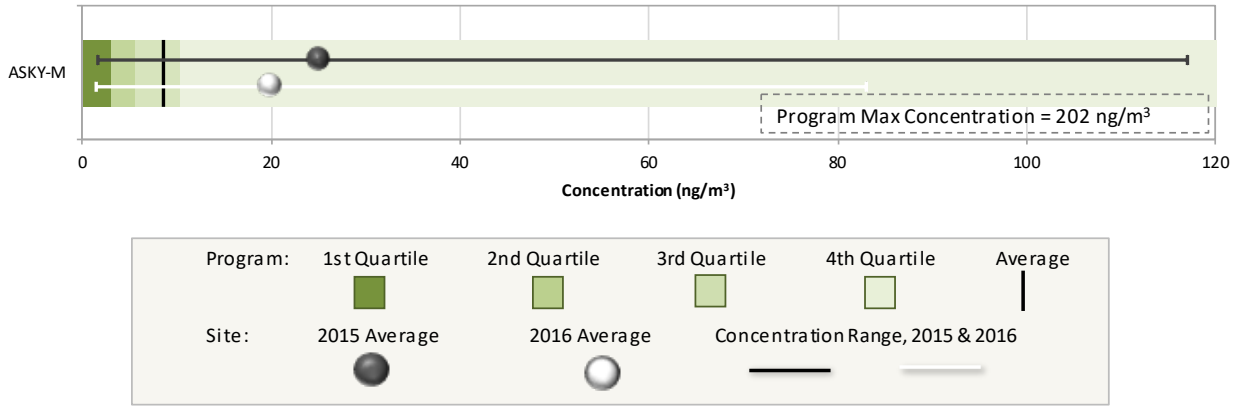


Figure 12-25 presents the box plot for manganese for ASKY-M and shows the following:

- The program-level maximum manganese concentration (202 ng/m^3) is not shown directly on the box plot as the scale of this box plot has also been reduced.

- ASKY-M is one of only two NMP sites for which manganese is a pollutant of interest.

- The maximum manganese concentration measured at ASKY-M in 2015 (117 ng/m^3) is the second highest concentration of manganese measured across the program; two additional manganese concentrations greater than 80 ng/m^3 were measured at ASKY-M, one in 2015 and one in 2016. Manganese concentrations measured at ASKY-M account for five of the nine highest concentrations measured across the program.

- Both of ASKY-M's annual average concentrations of manganese are more than two times greater than the program-level average concentration (8.51 ng/m^3), with ASKY-M's annual average concentration for 2015 nearly three times higher than the program-level average.

Figure 12-26. Program vs. Site-Specific Average Nickel (PM_{10}) Concentrations

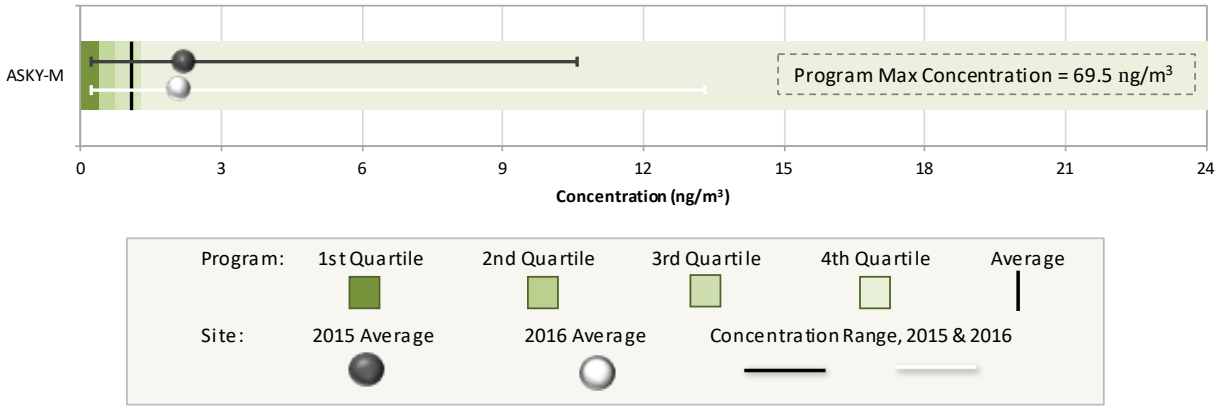


Figure 12-26 presents the box plot for nickel for ASKY-M and shows the following:

- The program-level maximum nickel concentration (69.5 ng/m^3) is not shown directly on the box plot as the scale of this box plot has also been reduced.

- Although the maximum nickel concentration measured each year at ASKY-M is considerably less than the maximum nickel concentration measured across the program, they are still among some of these highest nickel measurements.

- The annual average concentrations of nickel for ASKY-M are fairly similar to each other, with both approximately two times greater than the program-level average concentration (1.09 ng/m^3). Only one other NMP site has an annual average concentration of nickel greater than ASKY-M (among NMP sites sampling PM_{10} metals).

Figure 12-27. Program vs. Site-Specific Average 1,1,2-Trichloroethane Concentrations

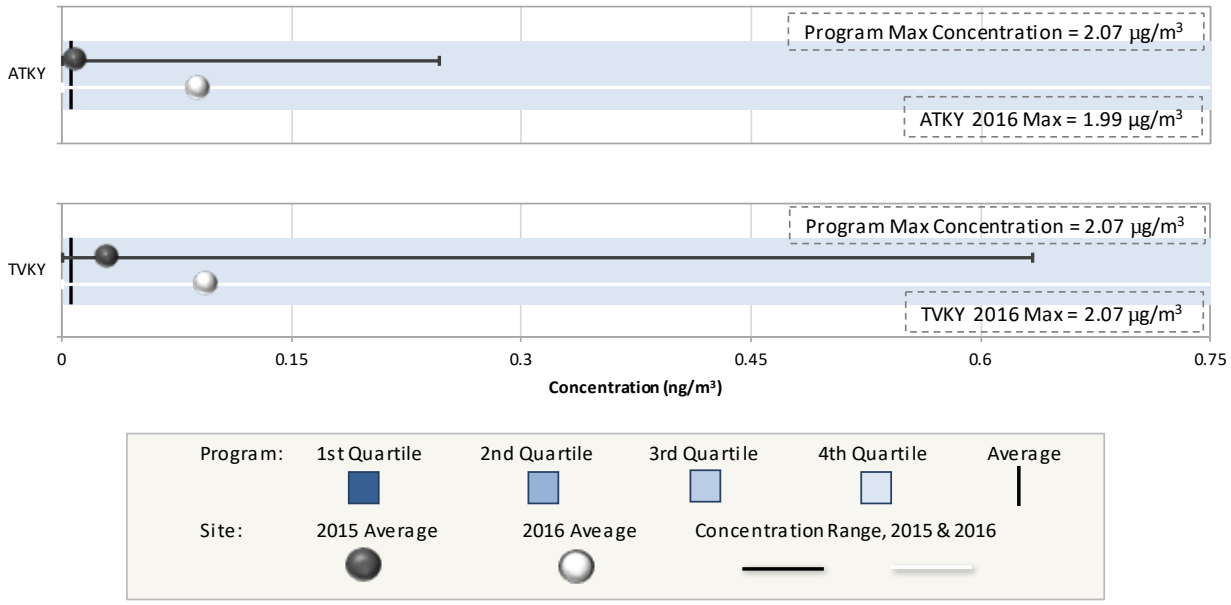


Figure 12-27 presents the box plot for 1,1,2-trichloroethane for ATKY and TVKY and shows the following:

- The program-level maximum concentration of 1,1,2-trichloroethane (2.07 µg/m^3) is not shown directly on the box plots as the scale has been reduced to allow for the observation of data points at the lower end of the concentration range. The program-level first, second, and third quartiles are all zero for this pollutant, indicating that at least 75 percent of the measurements across the program are non-detects and thus, are not visible on the box plots.

- ATKY and TVKY are the only NMP sites with 1,1,2-trichloroethane as a pollutant of interest.

- The two highest 1,1,2-trichloroethane concentrations measured across the program were measured at TVKY and ATKY, both in 2016. While the maximum concentrations of this pollutant measured at these sites in 2015 were considerably less, they are still among some of the highest measured across the program. These two sites account for 27 of the 32 1,1,2-trichloroethane concentrations greater than 0.1 µg/m^3 measured across the program (with BLKY accounting for the other five).

- For both sites, the annual average concentration for 2016 is greater than the annual average for 2015; the highest 1,1,2-trichloroethane concentrations were measured in 2016. Two concentrations greater than 1 µg/m^3 were measured at each of these sites in 2016; further, of the 27 1,1,2-trichloroethane concentrations greater than 0.1 µg/m^3 measured at these sites, 20 were measured in 2016 (nine at ATKY and 11 at TVKY).

Figure 12-28. Program vs. Site-Specific Average Vinyl Chloride Concentrations

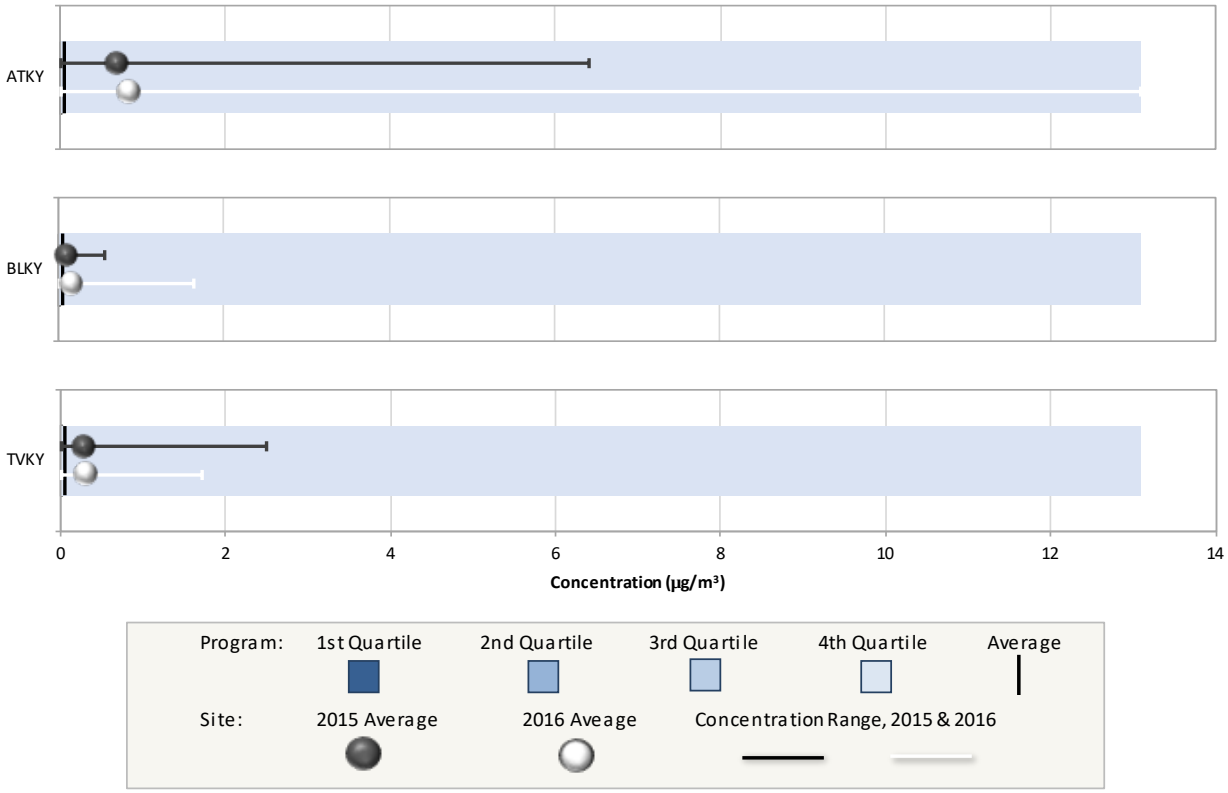


Figure 12-28 presents the box plots for vinyl chloride for the three Kentucky sites for which this pollutant was identified as a pollutant of interest and shows the following:

- The program-level first, second, and third quartiles are all zero for this pollutant, indicating that at least 75 percent of the measurements across the program are non-detects and thus, are not visible on the box plots.

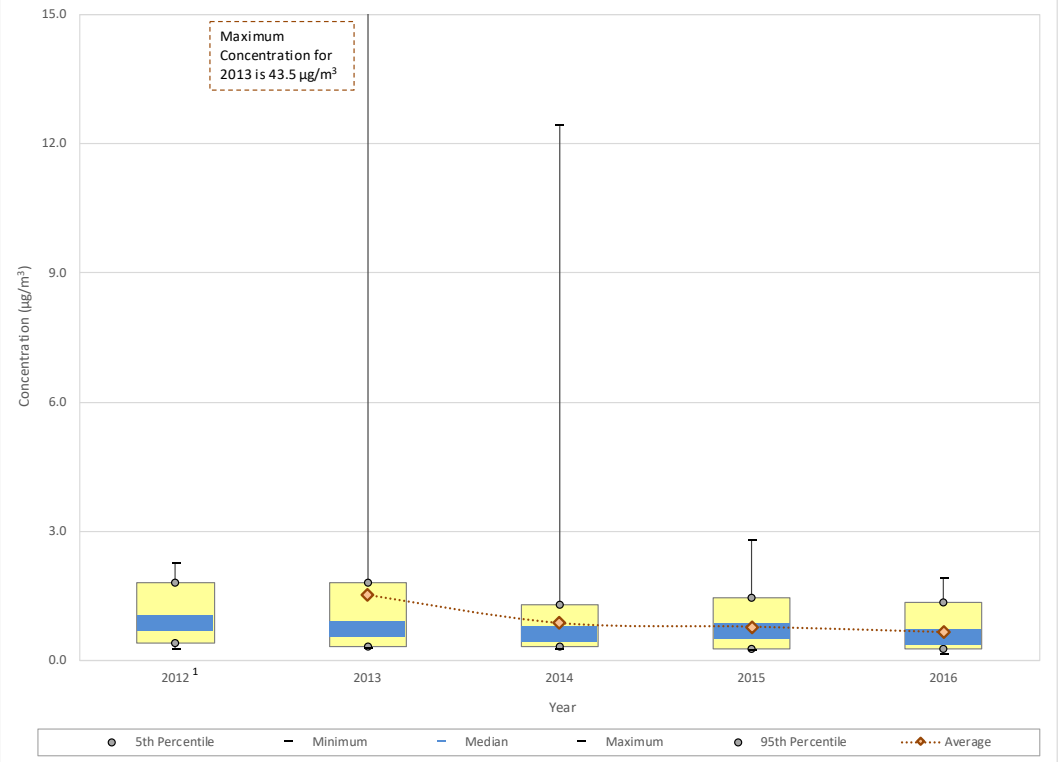
- The maximum vinyl chloride concentration measured at ATKY in 2016 (13.1 µg/m^3) is the maximum concentration measured across the program; the eight highest vinyl chloride concentrations measured across the program were measured at ATKY. Although the concentrations measured at BLKY and TVKY are lower in magnitude, its worth nothing that the 146 highest vinyl chloride concentrations measured across the program (those greater than 0.15 µg/m^3) were measured at these three sites.

- The annual average vinyl chloride concentrations for these sites range from 0.10 ± 0.04 µg/m^3 for BLKY (2015) to 0.83 ± 0.54 µg/m^3 for ATKY (2016), all of which are greater than the program-level average concentration of 0.05 µg/m^3. The annual averages for ATKY are considerably higher than the annual averages for the remaining two sites.

12.3.3 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the pollutants of interest for 5 consecutive years or longer, as described in Section 3.4.2.2. GLKY is the longest running NMP site in Kentucky; VOCs and PAHs have been sampled under the NMP since 2010, and sampling for carbonyl compounds and PM_{10} metals began in 2011. The remaining Kentucky sites began sampling under the NMP in 2012. Thus, Figures 12-29 through 12-71 present the 1-year statistical metrics for each of the pollutants of interest for the Kentucky sites in the same order presented in the previous sections. The statistical metrics presented for assessing trends include the substitution of zeros for non-detects. If sampling began mid-year, a minimum of 6 months of sampling is required for inclusion in the trends analysis; in these cases, a 1-year average concentration is not provided, although the range and percentiles are still presented.

Figure 12-29. Yearly Statistical Metrics for Benzene Concentrations Measured at ASKY



[1] A 1-year average is not presented because consistent sampling under the NMP began in July 2012.

Observations from Figure 12-29 for benzene concentrations measured at ASKY include the following:

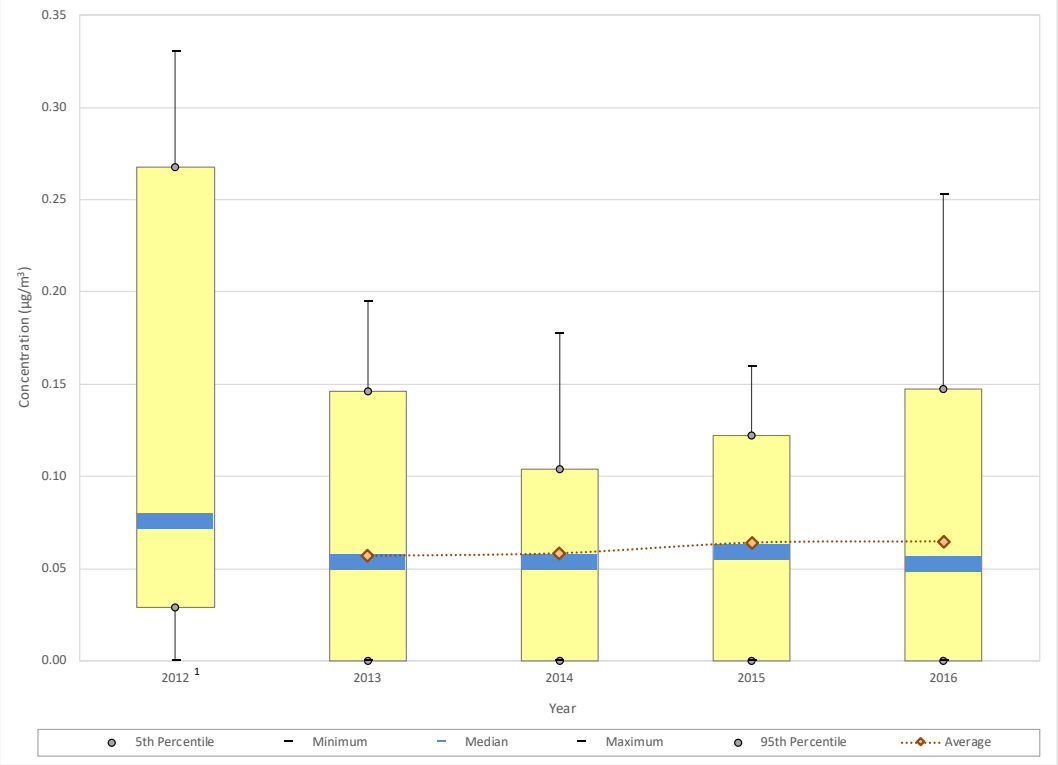
- Although sampling for VOCs at ASKY under the NMP began in March 2012, there was a 3-month break in sampling, after which sampling resumed in mid-July. Because a full year's worth of data is not available, a 1-year average concentration for 2012 is not presented, although the range of measurements is provided.

- The maximum benzene concentration measured at ASKY was measured on November 6, 2013 (43.5 µg/m^3). The second highest benzene concentration, which was measured in 2014, is nearly one-third the magnitude (12.4 µg/m^3). Only one other benzene concentration greater than 3 µg/m^3, which was also measured in 2013, has been measured at this site. The 1-year average concentration for 2013, though, is being driven upward by the outlier concentration measured; if this concentration was excluded from the calculation, the 1-year average concentration for 2013 would decrease by almost half.

- With the exception of a slight increase for 2015, the median benzene concentration has decreased each year through 2016, decreasing from 0.85 µg/m^3 for 2012 to 0.54 µg/m^3 from 2016. The 1-year average concentration has also decreased, from 1.52 µg/m^3 for 2013 to 0.65 µg/m^3 for 2016, representing a 57 percent decrease.

- With the exception of the 95th percentile, each of the statistical parameters is at a minimum for 2016.

Figure 12-30. Yearly Statistical Metrics for 1,3-Butadiene Concentrations Measured at ASKY



[1] A 1-year average is not presented because consistent sampling under the NMP began in July 2012.

Observations from Figure 12-30 for 1,3-butadiene concentrations measured at ASKY include the following:

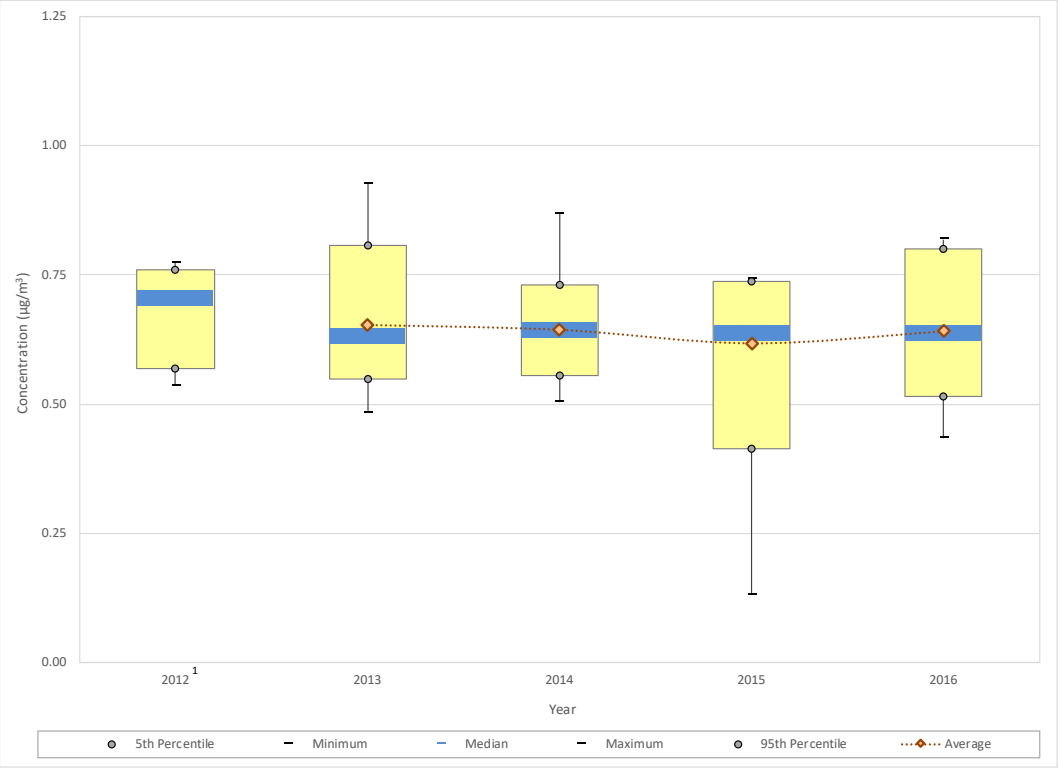
- The only two 1,3-butadiene concentrations greater than 0.30 µg/m^3 were measured at ASKY in 2012; 2012 has three times the number of 1,3-butadiene concentrations greater than 0.15 µg/m^3 (nine), compared to other years of sampling (three or less each year). 2012 is the only year in which the 5th percentile is greater than zero. Only one non-detect of 1,3-butadiene was measured in 2012; between four (2015) and fourteen (2013) were measured in the years that follow.

- All of the statistical parameters exhibit a decrease from 2012 to 2013 (except the minimum concentration, which did not change). The median concentration decreased by nearly 30 percent during this time; the number of 1,3-butadiene concentrations less than 0.1 µg/m^3 tripled between 2012 and 2013, increasing from 18 to 53.

- Between 2013 and 2016, the median concentration varied little, falling between 0.5 µg/m^3 and 0.6 µg/m^3 each year.

- Although the 1-year average concentration of 1,3-butadiene appears to increase between 2013 and 2016, the difference is not statistically significant; the change in the 1-year average concentration over these four years is 0.008 µg/m^3.

Figure 12-31. Yearly Statistical Metrics for Carbon Tetrachloride Concentrations Measured at ASKY



[1] A 1-year average is not presented because consistent sampling under the NMP began in July 2012.

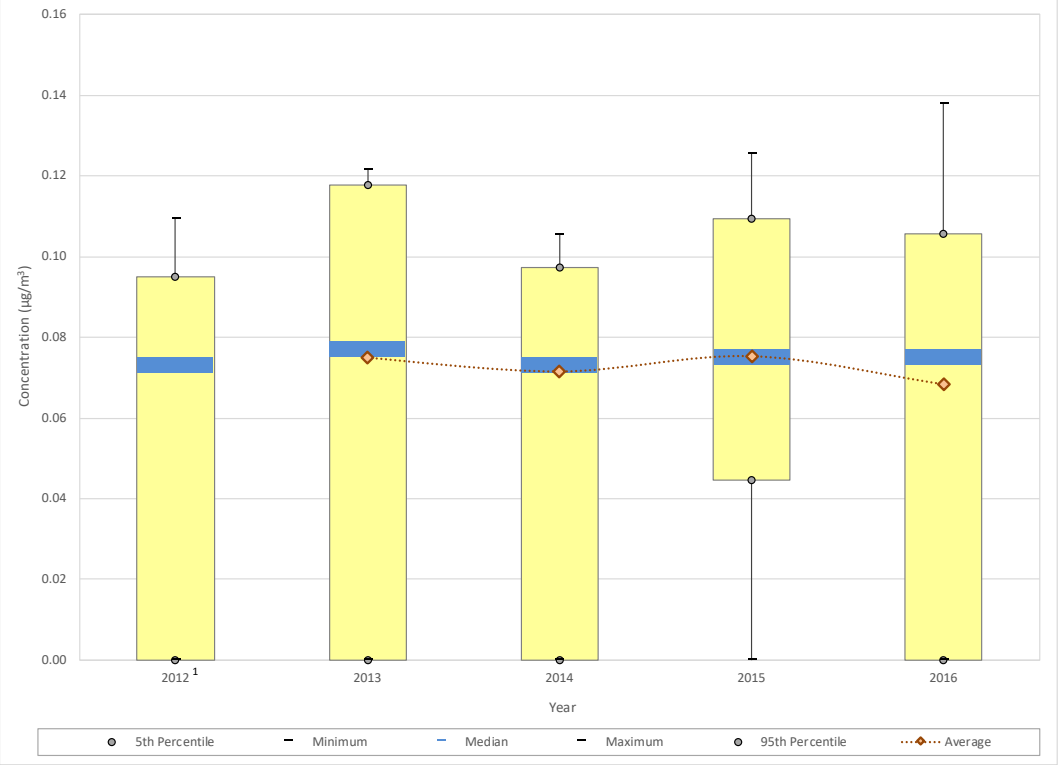
Observations from Figure 12-31 for carbon tetrachloride concentrations measured at ASKY include the following:

- Nearly 90 percent of the carbon tetrachloride concentrations measured at ASKY fall between 0.50 µg/m^3 and 0.75 µg/m^3. The two carbon tetrachloride concentrations greater than 0.90 µg/m^3 were measured at ASKY in 2013; the three carbon tetrachloride concentrations less than 0.40 µg/m^3 were measured at ASKY in 2015.

- The median concentration decreased from 0.71 µg/m^3 for 2012 to 0.63 µg/m^3 for 2013. Although similar in magnitude, carbon tetrachloride concentrations greater than 0.7 µg/m^3 accounted for 55 percent of the measurements in 2012; by comparison, these concentrations accounted for only 26 percent of the measurements in 2013. The median concentration varied between 0.63 µg/m^3 and 0.64 µg/m^3 for each of the years of sampling between 2013 and 2016.

- The 1-year average concentration varies by less than 0.04 µg/m^3 over the period shown. If 2015 is excluded, less than 0.02 µg/m^3 separates these parameters. The four lowest carbon tetrachloride concentrations were measured at ASKY in 2015, including the only measurement less than 0.25 µg/m^3. In addition, 2015 is the only year in which a measurement greater than 0.75 µg/m^3 was not measured.

Figure 12-32. Yearly Statistical Metrics for 1,2-Dichloroethane Concentrations Measured at ASKY



[1] A 1-year average is not presented because consistent sampling under the NMP began in July 2012.

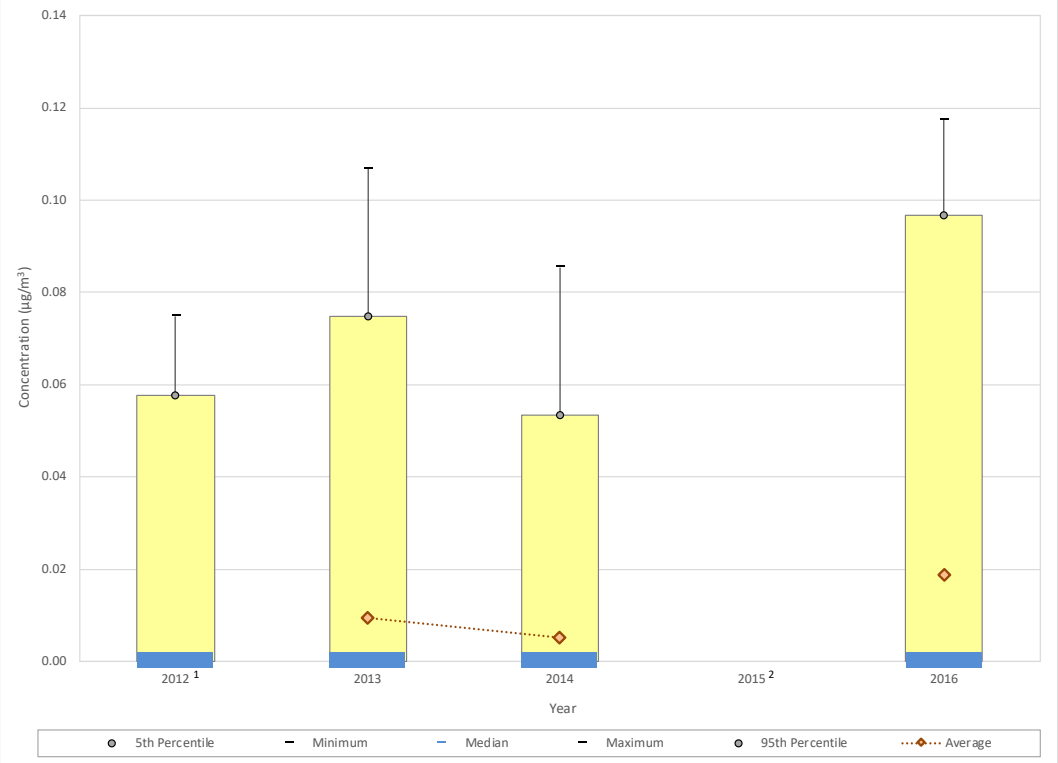
Observations from Figure 12-32 for 1,2-dichloroethane concentrations measured at ASKY include the following:

- The maximum 1,2-dichloroethane concentration measured each year has varied little, ranging from 0.105 µg/m^3 (2014) to 0.138 µg/m^3 (2016).

- The minimum concentration measured each year is zero, indicating the substitution of zero(s) for at least one non-detect; with the exception of 2015, the 5th percentile is also zero. The number of non-detects measured has ranged from one (2015) to eight (2013).

- The median 1,2-dichloroethane concentration has changed little over the years of sampling, falling between 0.07 µg/m^3 and 0.08 µg/m^3. This is also true for the 1-year average concentration.

Figure 12-33. Yearly Statistical Metrics for Hexachloro-1,3-butadiene Concentrations Measured at ASKY



[1] A 1-year average is not presented because consistent sampling under the NMP began in July 2012.
[2] A 1-year average is not presented due to a laboratory contamination issue affecting numerous samples.

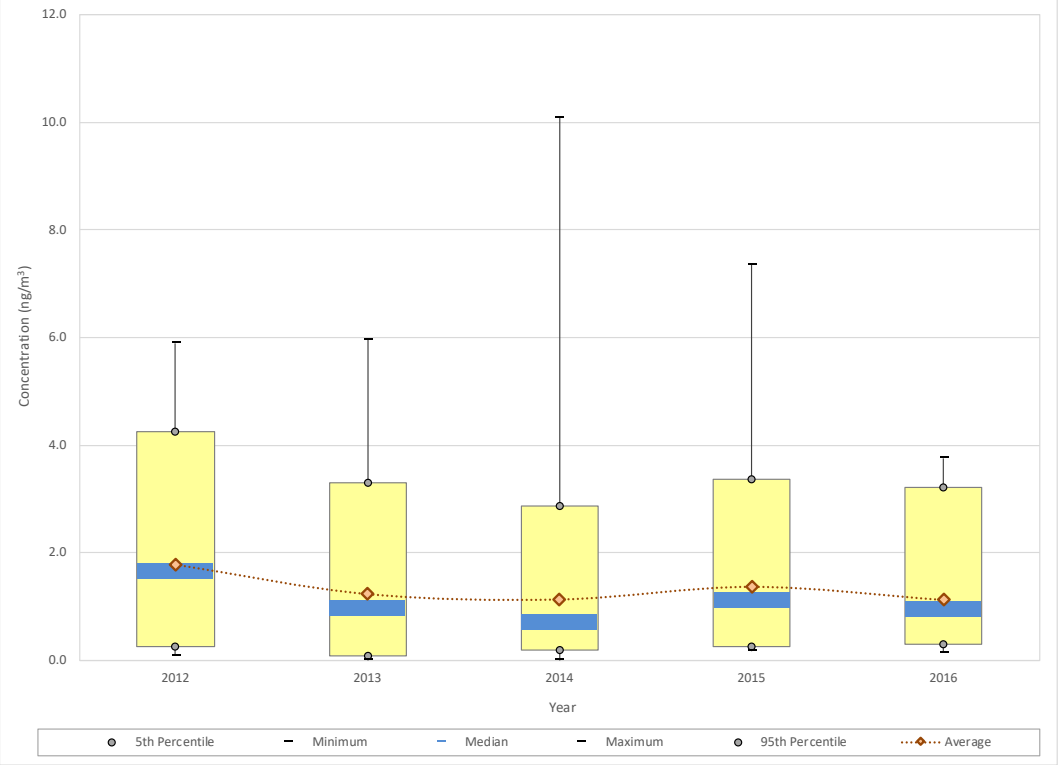
Observations from Figure 12-33 for hexachloro-1,3-butadiene concentrations measured at ASKY include the following:

- The use of a contaminated internal standard at the laboratory for Method TO-15 resulted in the invalidation of the hexachloro-1,3-butadiene measurements from early March 2015 through mid-December 2015, as described in Section 2.4.

- The minimum, 5th percentile, and median concentration for each year is zero, where available, indicating that at least 50 percent of the measurements were non-detects. The percentage of non-detects measured has ranged from 75 percent (2016) to 92 percent (2014).

- Three of the four highest hexachloro-1,3-butadiene concentrations were measured at ASKY in 2016. The maximum concentration measured is 0.118 µg/m^3; the next highest concentration (0.107 µg/m^3) has been measured three times, once in 2013 and twice in 2016. No other concentrations greater than 0.1 µg/m^3 have been measured at this site. The majority of measured detections fall between 0.05 µg/m^3 and 0.1 µg/m^3 (though accounting for no more than 25 percent of measurements for any given year).

Figure 12-34. Yearly Statistical Metrics for Arsenic (PM_{10}) Concentrations Measured at ASKY-M



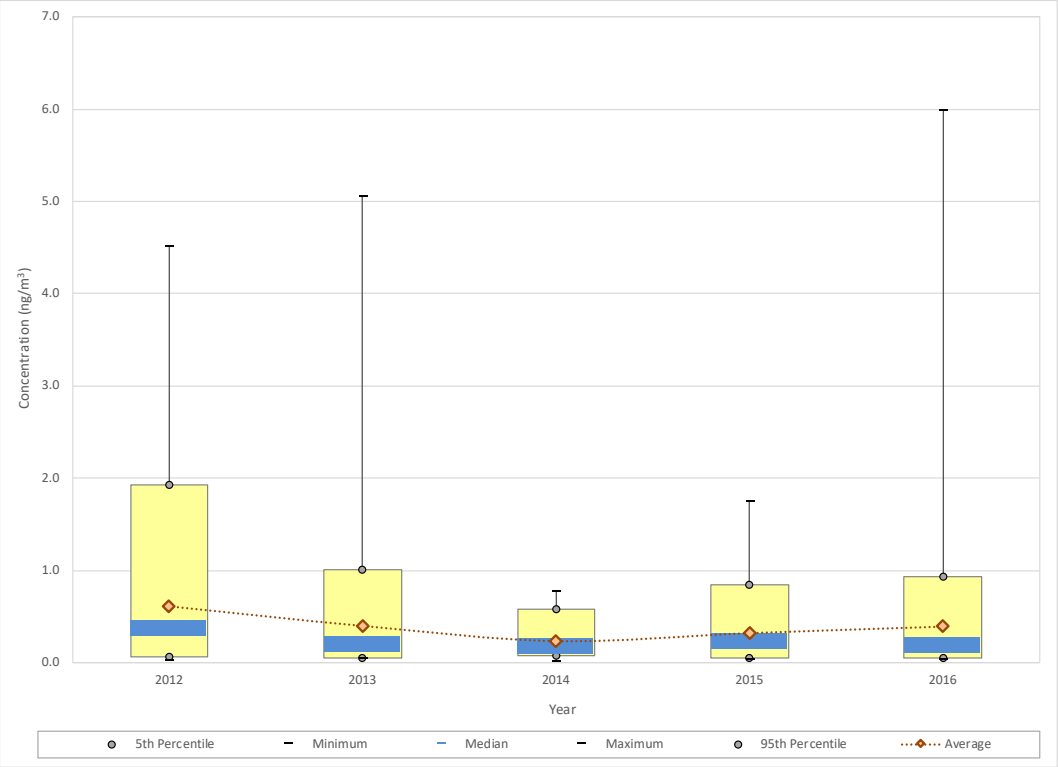
Observations from Figure 12-34 for arsenic (PM_{10}) concentrations measured at ASKY-M include the following:

- The maximum arsenic concentration (10.1 ng/m^3) was measured at ASKY-M in 2014. Arsenic concentrations greater that 4 ng/m^3 were measured during each year of sampling except 2016.

- Both the 1-year average and median concentrations are at a maximum for 2012, after which each exhibits a decrease through 2014. The number of arsenic concentrations greater than 2 ng/m^3 is at its highest for 2012 (26), after which the number decreased by half for 2013 (13), then in half again for 2014 (7).

- Most of the statistical parameters exhibit a slight increase for 2015, which is followed by a slight decrease for 2016, when the smallest range of arsenic concentrations was measured.

Figure 12-35. Yearly Statistical Metrics for Cadmium (PM_{10}) Concentrations Measured at ASKY-M

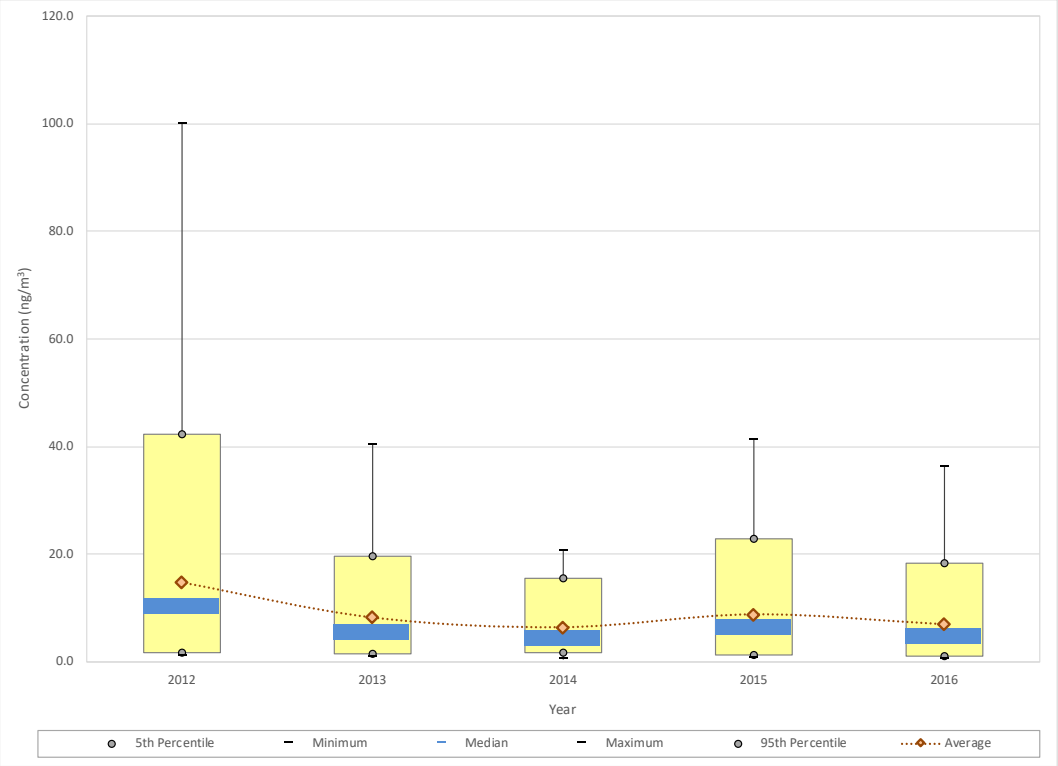


Observations from Figure 12-35 for cadmium (PM_{10}) concentrations measured at ASKY-M include the following:

- A significant decreasing trend in cadmium concentrations measured at ASKY-M is shown between 2012 and 2014. The number of cadmium concentrations greater than 1 ng/m^3 measured at ASKY-M decreased from 12 in 2012 to three in 2013 to none in 2014. Both the 1-year average and median concentrations decreased by more than half during this time and most of the statistical parameters are at a minimum for 2014.

- Cadmium concentrations of increasing magnitude were measured in 2015 and 2016, when the maximum cadmium concentration was measured (5.99 ng/m^3). The 1-year average concentration increases for 2015 and again for 2016, although the increase for 2016 is mostly due to the magnitude of the maximum concentration measured (the next highest concentration is one-fifth as high).

Figure 12-36. Yearly Statistical Metrics for Lead (PM_{10}) Concentrations Measured at ASKY-M



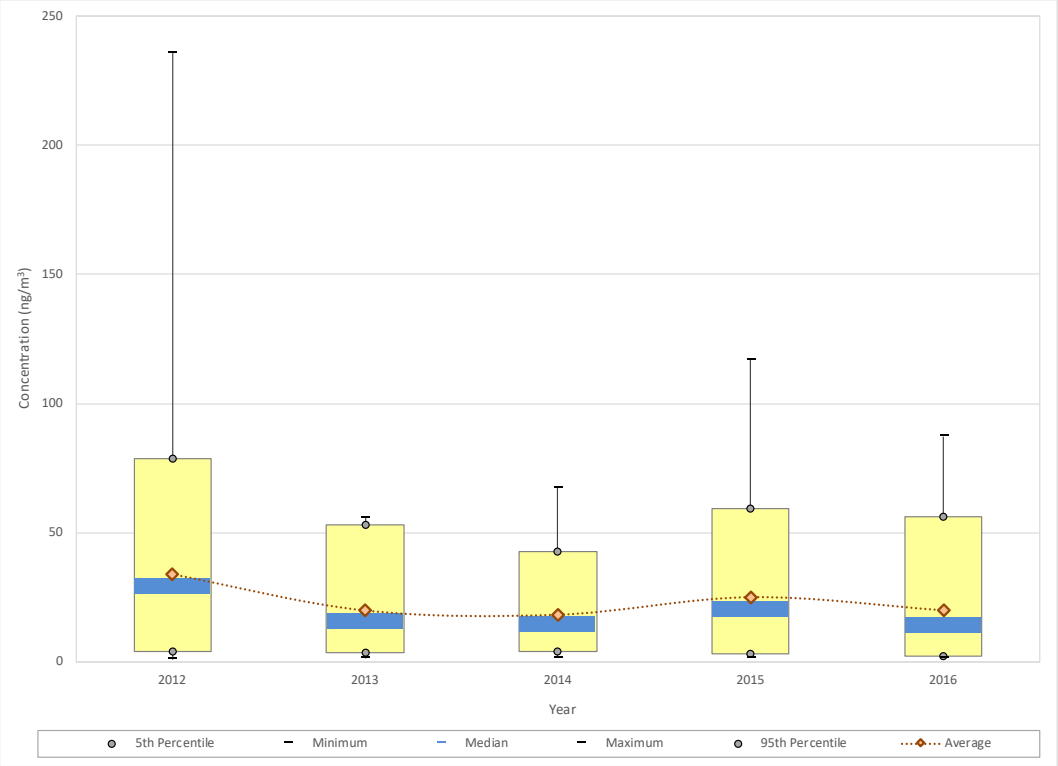
Observations from Figure 12-36 for lead (PM_{10}) concentrations measured at ASKY-M include the following:

- The five highest lead concentrations were all measured at ASKY-M in 2012, including the maximum concentration (100.1 ng/m^3). The second, third, fourth, and fifth highest lead concentrations were half as high, falling between 40 ng/m^3 and 50 ng/m^3. Concentrations of lead greater than 40 ng/m^3 were also measured in 2013 and 2015.

- Similar to cadmium, concentrations of lead decreased significantly between 2012 and 2014, with the 1-year average concentration decreasing from 14.76 ng/m^3 to 6.44 ng/m^3 during this time. The median concentration exhibits a similar pattern.

- Most of the statistical parameters exhibit increases from 2014 to 2015, which is followed by slight decreases for 2016.

Figure 12-37. Yearly Statistical Metrics for Manganese (PM_{10}) Concentrations Measured at ASKY-M



Observations from Figure 12-37 for manganese (PM_{10}) concentrations measured at ASKY-M include the following:

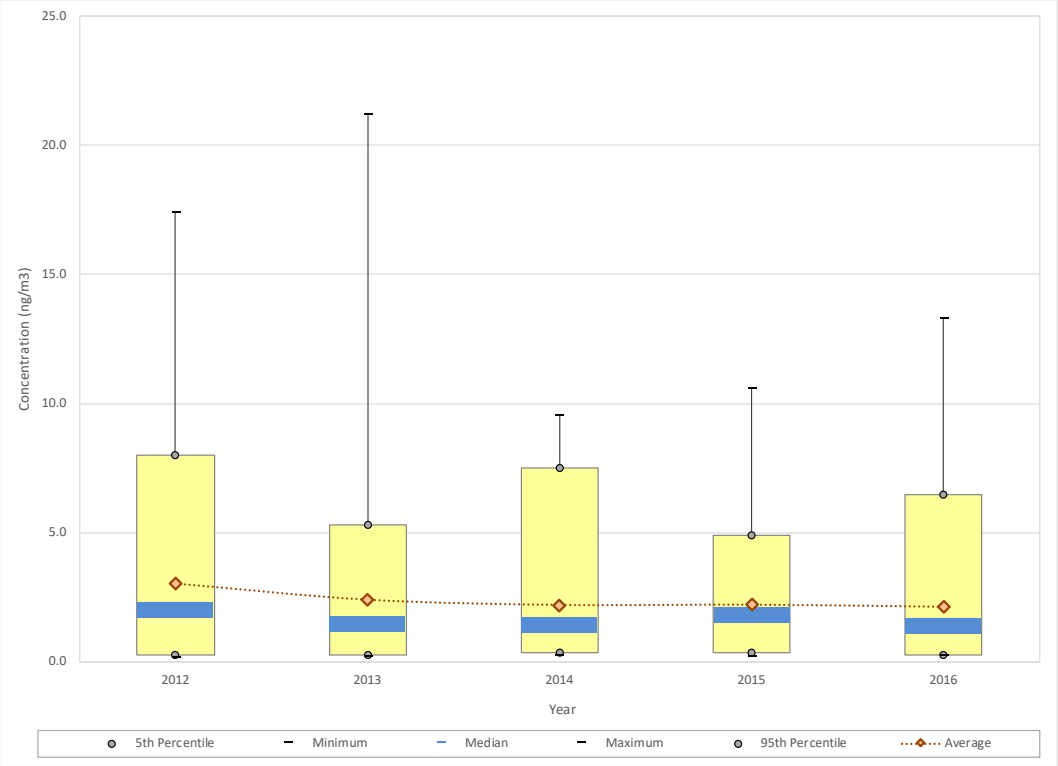
- The trends graph for manganese resembles the trends graph for several of the other metals pollutants of interest for ASKY-M.

- The maximum manganese concentration (236 ng/m^3) was measured at ASKY-M in 2012. Two additional manganese concentrations greater than 100 ng/m^3 have been also measured at ASKY-M, one in 2015 (117 ng/m^3) and the other in 2012 (115 ng/m^3). Manganese concentrations greater than 50 ng/m^3 have been measured at ASKY-M during each year of sampling (a total of 29), with the most measured in 2012 (12).

- Similar to lead, concentrations of manganese decreased significantly between 2012 and 2014, with the 1-year average concentration decreasing from 33.95 ng/m^3 to 18.21 ng/m^3 during this time. The median concentration exhibits a similar pattern.

- Most of the statistical parameters exhibit increases from 2014 to 2015, which is followed by slight decreases for 2016.

Figure 12-38. Yearly Statistical Metrics for Nickel (PM_{10}) Concentrations Measured at ASKY-M

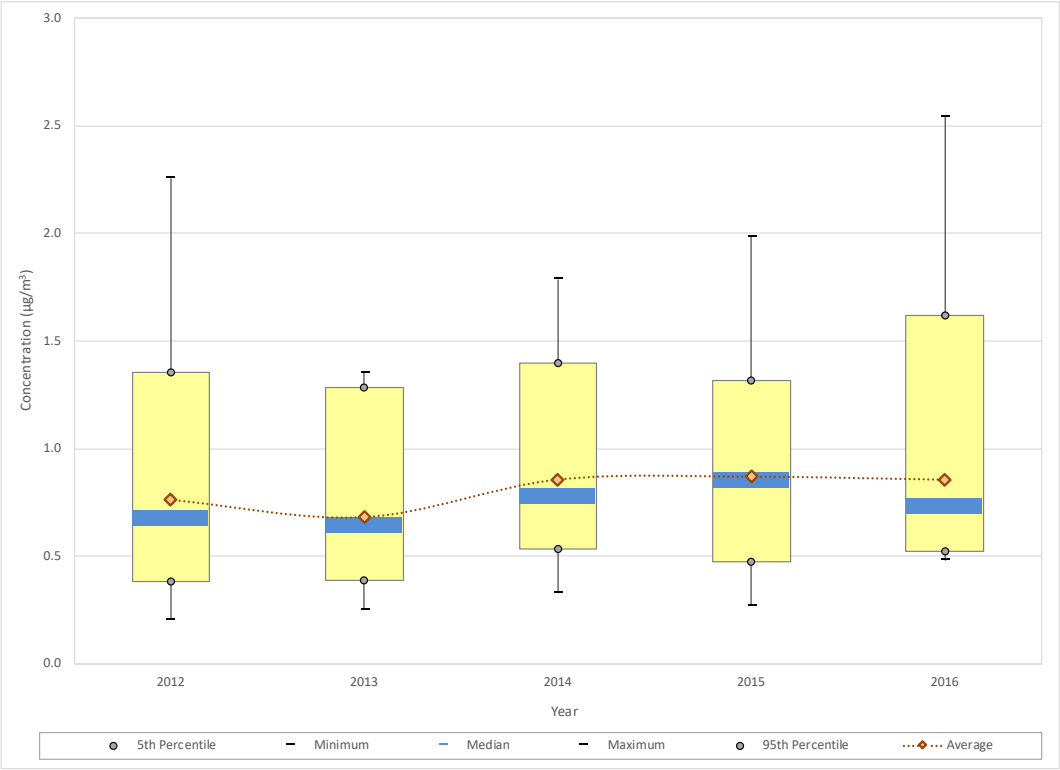


Observations from Figure 12-38 for nickel (PM_{10}) concentrations measured at ASKY-M include the following:

- The maximum nickel concentration was measured at ASKY-M in 2013 (21.2 ng/m^3). Nickel concentrations greater than 10 ng/m^3 have been measured at ASKY-M during each year of sampling except 2014.

- Although the 1-year average concentration of nickel has decreased by nearly 1 ng/m^3 over the course of sampling, most of this decrease occurred between 2012 and 2013. The median has a similar pattern until 2015, when a slight increase is shown; this is followed by additional decreases for 2016. Both central tendency parameters are at a minimum for 2016. However, confidence intervals calculated on the data indicate that the change is not statistically significant.

Figure 12-39. Yearly Statistical Metrics for Acetaldehyde Concentrations Measured at GLKY



Observations from Figure 12-39 for acetaldehyde concentrations measured at GLKY include the following:

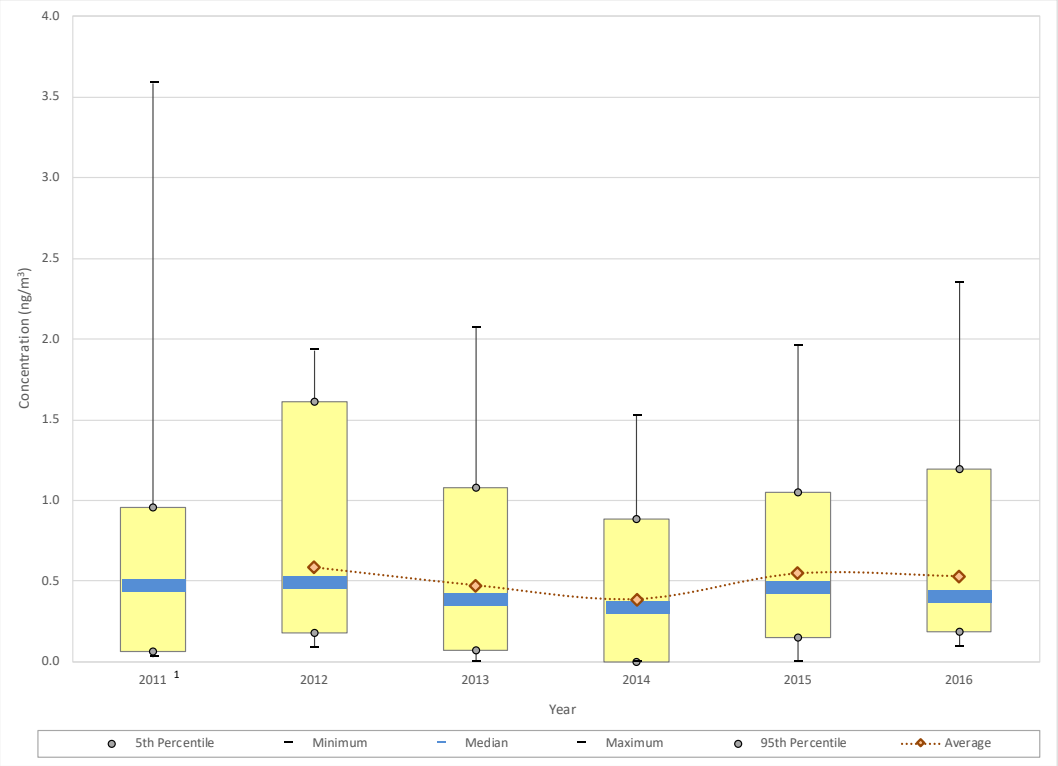
- GLKY began sampling carbonyl compounds under the NMP in August 2011. However, data from 2011 is excluded because this represents less than 6 months of sampling, as described in Section 3.4.2.2**,** and thus, Figure 12-39 begins with 2012.

- The range of acetaldehyde concentrations measured at GLKY compressed from 2012 to 2013, although the majority of concentrations fell within a relatively similar range both years, as indicated by the 5th and 95th percentiles. The decrease shown in the 1-year average and median concentrations for 2013 results not just from the lower maximum concentration; the number of acetaldehyde concentrations greater than 1 µg/m^3 fell to eight in 2013, from 13 in 2012, which included four measurements greater than the maximum concentration measured in 2013.

- All of the statistical parameters exhibited increases for 2014, when the number of acetaldehyde concentrations greater than 1 µg/m^3 doubled (16) and concentrations greater than 0.75 µg/m^3 account for more than half of measurements. The fifth percentile is also greater than 0.5 µg/m^3, indicating that fewer "low" concentrations were measured.

- The 1-year average concentration holds steady between 2014 and 2016, despite increasingly higher acetaldehyde concentrations being measured. The median concentration is at a maximum for 2015, then decreases somewhat for 2016.

Figure 12-40. Yearly Statistical Metrics for Arsenic (PM_{10}) Concentrations Measured at GLKY



[1] A 1-year average is not presented because sampling under the NMP did not begin until May 2011.

Observations from Figure 12-40 for arsenic (PM_{10}) concentrations measured at GLKY include the following:

- Sampling for PM_{10} metals at GLKY under the NMP began in May 2011; because a full year's worth of data is not available, a 1-year average concentration for 2011 is not presented, although the range of measurements is provided.

- The maximum arsenic concentration measured at GLKY was measured in 2011 (3.56 ng/m^3); no other arsenic concentrations greater than 3 ng/m^3 have been measured at GLKY. Three arsenic concentrations greater than 2 ng/m^3 have been measured, one in 2013 and two in 2016.

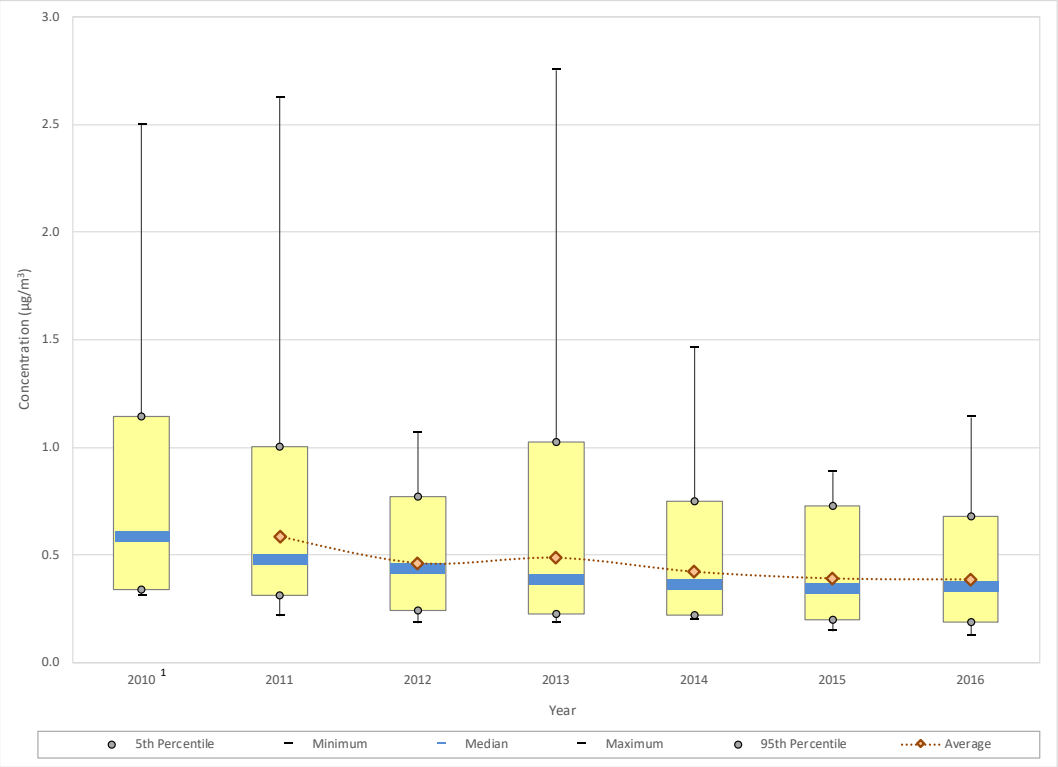
- The median arsenic concentration exhibits little change from 2011 to 2012, despite the changes shown in the concentration profiles for these years (e.g., the decrease in the maximum concentration measured, the increase in the 5th and 95th percentiles).

- All of the statistical parameters exhibit a decreasing trend between 2012 and 2014, when all of the parameters are at a minimum, and when the first non-detects (four) of arsenic were measured.

- With the exception of the minimum concentration, each of the statistical parameters increases for 2015, each returning to near 2013 levels. Most of the statistical parameters exhibit further increases for 2016, although the 1-year average changes

little and the median exhibits a slight decrease. Non-detects were not measured at GLKY in 2016.

Figure 12-41. Yearly Statistical Metrics for Benzene Concentrations Measured at GLKY



[1] A 1-year average is not presented because sampling under the NMP did not begin until June 2010.

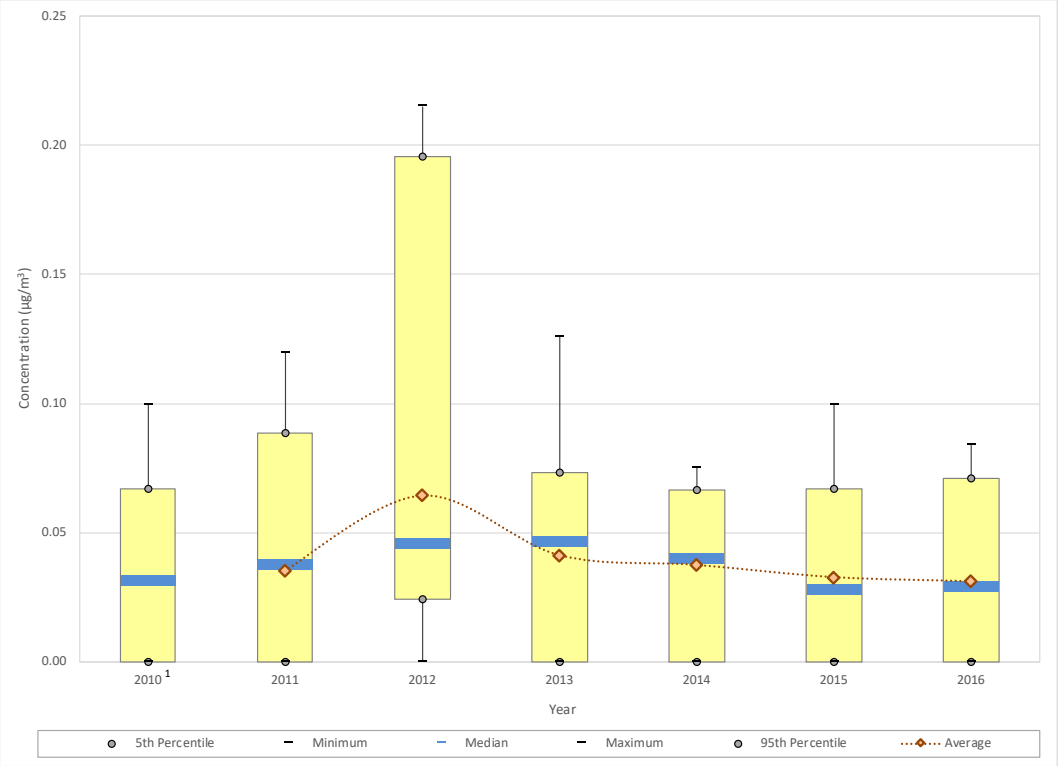
Observations from Figure 12-41 for benzene concentrations measured at GLKY include the following:

- GLKY began sampling VOCs under the NMP in June 2010. Because a full year's worth of data is not available, a 1-year average concentration for 2010 is not presented, although the range of measurements is provided.

- The maximum benzene concentration was measured at GLKY in August 2013 (2.75 µg/m^3); this measurement is one of only three benzene concentrations greater than 2 µg/m^3 measured at this site.

- The median benzene concentration exhibits a decreasing trend through 2015, decreasing from 0.59 µg/m^3 for 2010 to 0.34 µg/m^3 for 2015 (with little change for 2016). The 1-year average concentration exhibits a similar pattern, decreasing from 0.58 µg/m^3 in 2011 to 0.39 µg/m^3 in 2015 and 2016, although there is a slight increase shown from 2012 to 2013. If the maximum concentration measured in 2013 was excluded from the dataset, the 1-year average concentration would exhibit a pattern similar to the 1-year median concentration.

Figure 12-42. Yearly Statistical Metrics for 1,3-Butadiene Concentrations Measured at GLKY



[1] A 1-year average is not presented because sampling under the NMP did not begin until June 2010.

Observations from Figure 12-42 for 1,3-butadiene concentrations measured at GLKY include the following:

- The eight highest 1,3-butadiene concentrations were measured at GLKY in 2012 and account for all of the measurements greater than 0.15 µg/m^3.

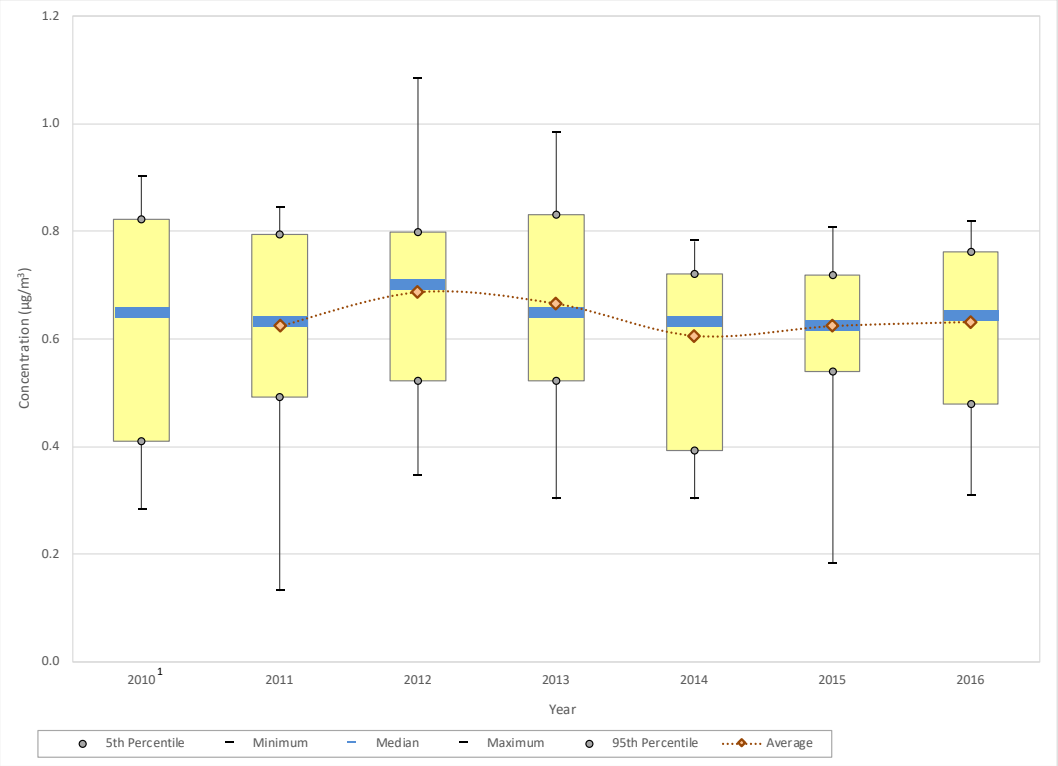
- In addition to having the concentrations of highest magnitude, 2012 is also the year with the fewest non-detects; two non-detects were measured in 2012, compared to between nine (2014, 2015) and 18 (2011) for the remaining years.

- The 1-year average concentration nearly doubled from 2011 to 2012, as a result of the higher concentrations and reduced number of non-detects.

- The 1-year average concentration decreased significantly from 2012 to 2013, with additional decreases shown each year through 2016, when the 1-year average is at a minimum (0.031 µg/m^3). During this time, the majority of concentrations, as indicated by the difference in the 5th and 95th percentiles, fell within a similar range.

- The median concentration does not exhibit quite the same pattern as the 1-year average. The median concentration increases each year between 2010 and 2013, reaching a maximum one year later than the 1-year average, although the difference between the median concentrations for these two years is rather small. The median concentration decreases after 2013, falling to less than 0.03 µg/m^3 for 2015 and 2016.

Figure 12-43. Yearly Statistical Metrics for Carbon Tetrachloride Concentrations Measured at GLKY



[1] A 1-year average is not presented because sampling under the NMP did not begin until June 2010.

Observations from Figure 12-43 for carbon tetrachloride concentrations measured at GLKY include the following:

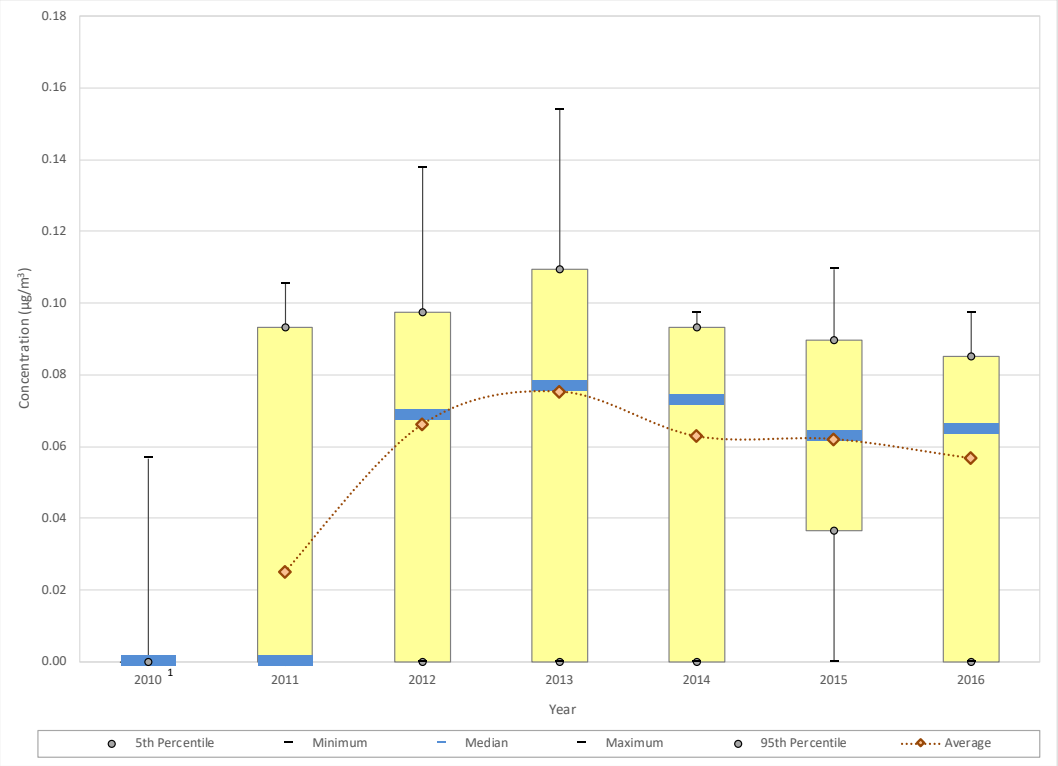
- Only one carbon tetrachloride concentration greater than 1 µg/m^3 has been measured at GLKY (March 2012).

- All of the statistical parameters exhibit an increase from 2011 to 2012, although the majority of concentrations, as indicated by the 5th and 95th percentiles, fell into a similar range. The number of carbon tetrachloride measurements between 0.7 µg/m^3 and 0.8 µg/m^3 more than doubled, from 11 measured in 2011 to 25 in 2012.

- Decreases in the 1-year average concentration are shown from 2012 to 2013 as the number of carbon tetrachloride measurements between 0.7 µg/m^3 and 0.8 µg/m^3 accounts for fewer measurements (falling to 14 from 25). Most of the statistical parameters exhibit decreases from 2013 to 2014, with the exception of the minimum concentration, which did not change. Several parameters are at a minimum for 2014, which is the first year without a measurement greater than 0.8 µg/m^3.

- Slight increases in the 1-year average concentration are shown for 2015 and 2016, though the changes are not statistically significant. In fact, the 1-year average concentrations vary by less than 0.1 µg/m^3 over the period of sampling. This is also true for the median concentration.

Figure 12-44. Yearly Statistical Metrics for 1,2-Dichloroethane Concentrations Measured at GLKY



[1] A 1-year average is not presented because sampling under the NMP did not begin until June 2010.

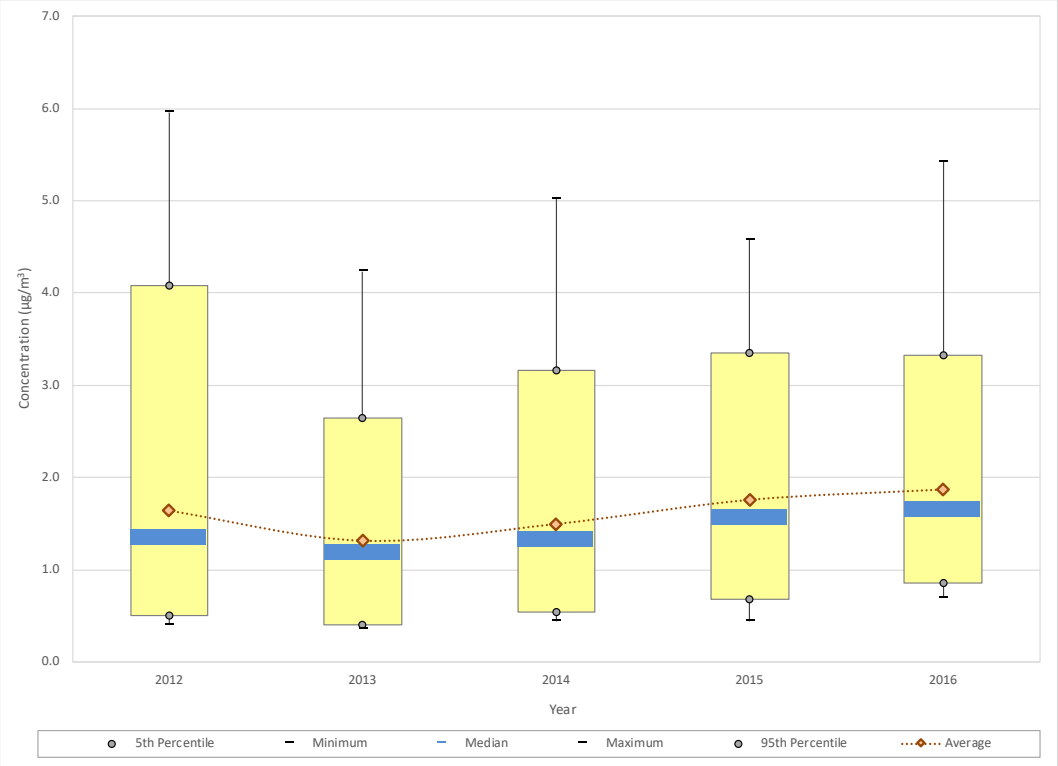
Observations from Figure 12-44 for 1,2-dichloroethane concentrations measured at GLKY include the following:

- There was one measured detection of 1,2-dichloroethane in 2010. The number of measured detections increased to 19 for 2011, and 54 in 2012, accounting for 90 percent of the measurements. Between 2012 and 2016, the number of measured detections has ranged from 48 (2014) to 58 (2015).

- As the number of non-detects decreased and measured detections increased, the 1-year average and median concentrations increased correspondingly, each reaching a maximum for 2013. A significant decrease in the 1-year average concentration is shown after 2013, and by 2016 1-year average is less than 0.06 µg/m^3 for the first time since 2011.

- The median concentration is greater than the 1-year average concentration for each year between 2012 and 2016. This is because there were still several non-detects (or zeros) factoring into the 1-year average concentration for each year: 2012 (6), 2013 (5), 2014 (8), 2015 (2), and 2016 (10), which drive the 1-year average concentrations down in the same manner that a maximum or outlier concentration can drive the average up. The increase in non-detects is the primary reason for the decreases in several of the parameters shown for 2016.

Figure 12-45. Yearly Statistical Metrics for Formaldehyde Concentrations Measured at GLKY



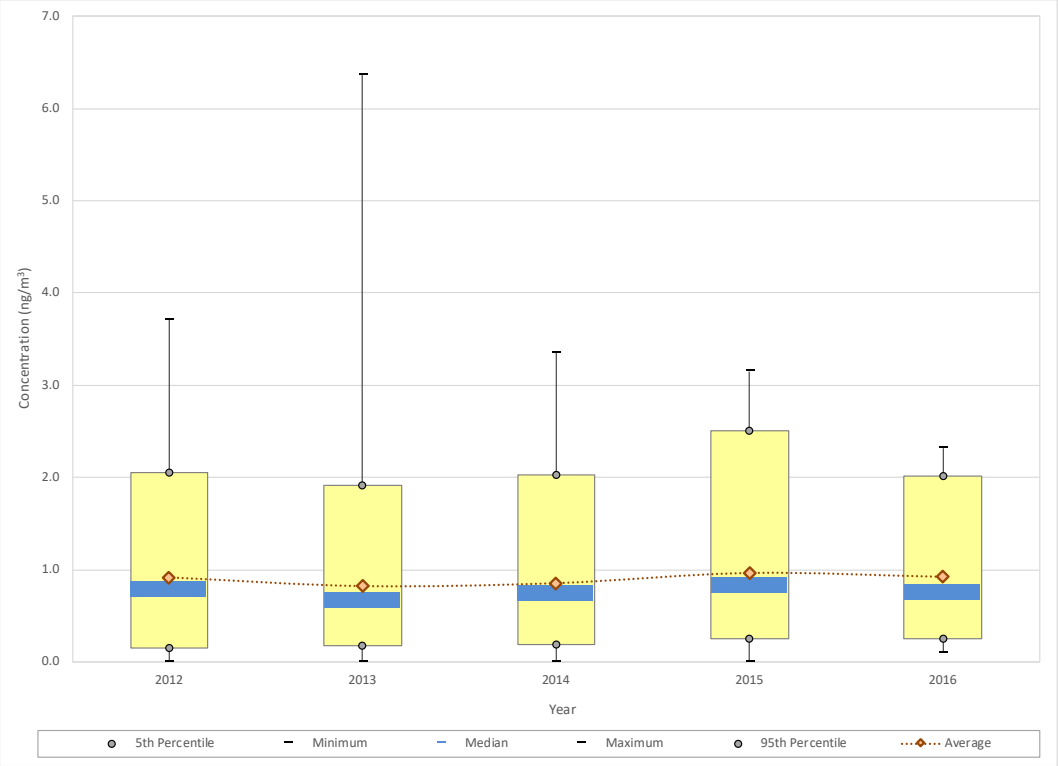
Observations from Figure 12-45 for formaldehyde concentrations measured at GLKY include the following:

- The maximum formaldehyde concentration (5.96 µg/m^3) was measured at GLKY in 2012. Three additional formaldehyde concentrations greater than 5 µg/m^3 have been measured, another in 2012, plus one each in 2014 and 2016.

- Each of the statistical parameters exhibits a decrease from 2012 to 2013, particularly those representing the upper end of the concentration range.

- A steady increasing trend in formaldehyde concentrations measured at GLKY is shown each year after 2013, with both the 1-year average and median concentration at a maximum for 2016.

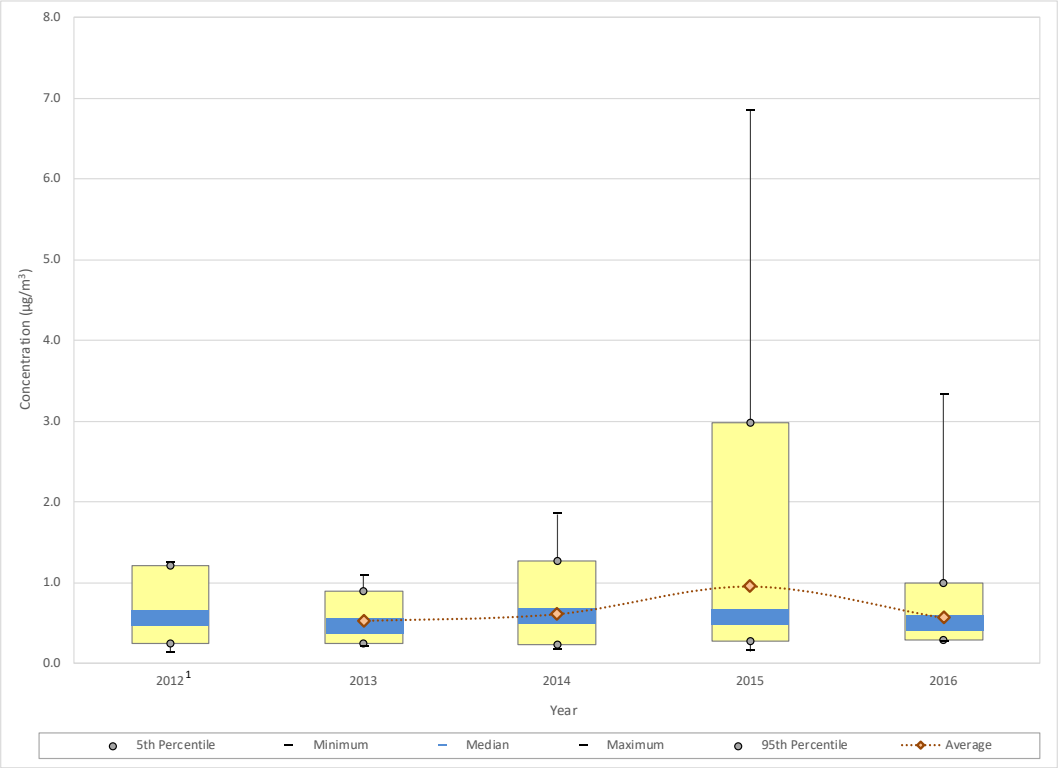
Figure 12-46. Yearly Statistical Metrics for Arsenic (PM_{10}) Concentrations Measured at BAKY



Observations from Figure 12-46 for arsenic (PM_{10}) concentrations measured at BAKY include the following:

- BAKY began sampling PM_{10} metals in March 2012.
- The maximum arsenic concentration measured at BAKY was measured in 2013 (6.37 ng/m^3). Additional arsenic concentrations greater than 4 ng/m^3 have not been measured at BAKY.
- Although concentrations at the upper end of the concentration range have varied across the years, the majority of arsenic concentrations measured have changed little over the years of sampling. The central tendency parameters have varied by less than 0.2 ng/m^3 over the years: the 1-year average concentration has ranged from 0.82 ng/m^3 (2013) to 0.96 ng/m^3 (2015). The median concentration has ranged from 0.66 ng/m^3 (2013) to 0.83 ng/m^3 (2015).

Figure 12-47. Yearly Statistical Metrics for Benzene Concentrations Measured at ATKY



[1] A 1-year average is not presented because consistent sampling under the NMP began in July 2012.

Observations from Figure 12-47 for benzene concentrations measured at ATKY include the following:

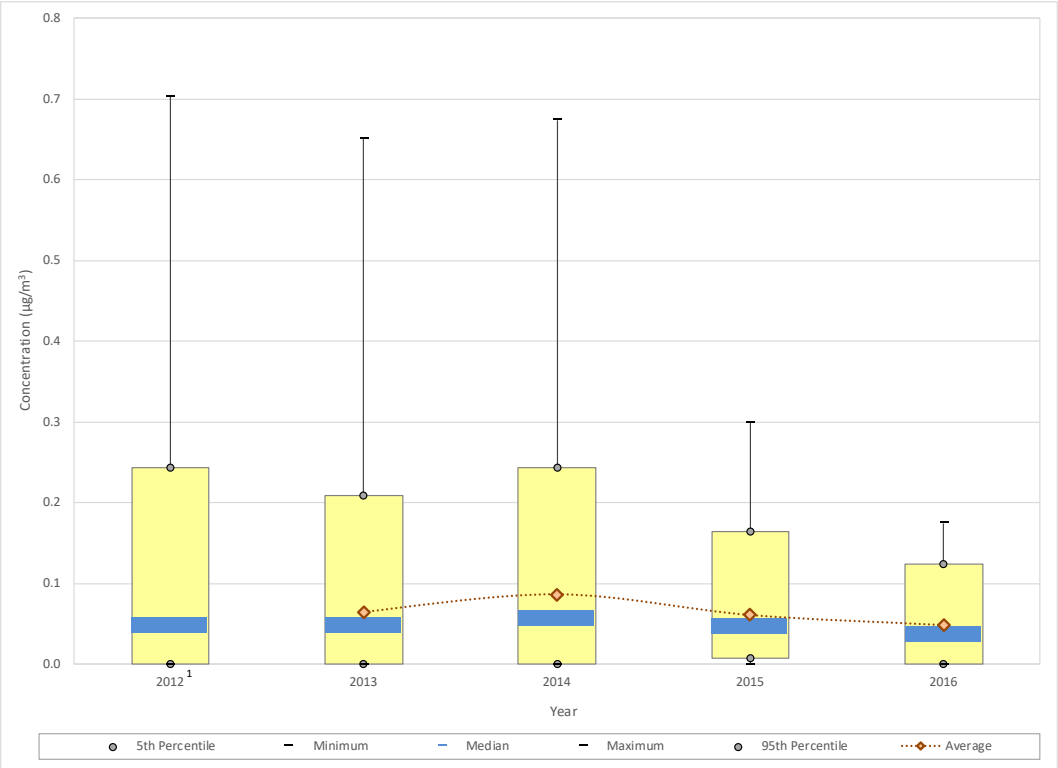
- Although sampling for VOCs at ATKY under the NMP began in March 2012, there was a 3-month break in sampling, then sampling resumed in mid-July. Because a full year's worth of data is not available, a 1-year average concentration for 2012 is not presented, although the range of measurements is provided.

- The three highest benzene concentrations were measured in 2015, ranging from 5.47 µg/m^3 to 6.85 µg/m^3. Benzene concentrations greater than 1.25 µg/m^3 were not measured prior to 2014, with 11 of these 16 concentrations measured in 2015 (with four measured in 2014 and one measured in 2016).

- The entire range of benzene concentrations measured at ATKY in 2012 spans just over 1 µg/m^3. The range is even smaller for 2013. The range of measurements nearly doubles from 2013 to 2014, then increases four-fold for 2015. The 1-year average concentration nearly doubles from 2013 to 2015; only two concentrations measured in 2013 and seven measured in 2014 are greater than the 1-year average concentration for 2015.

- With the exception of the maximum concentration (3.33 µg/m^3), the concentration profile for 2016 more closely resembles the concentration profile for 2013. If the maximum concentration was excluded, this would be even more true.

Figure 12-48. Yearly Statistical Metrics for 1,3-Butadiene Concentrations Measured at ATKY



[1] A 1-year average is not presented because consistent sampling under the NMP began in July 2012.

Observations from Figure 12-48 for 1,3-butadiene concentrations measured at ATKY include the following:

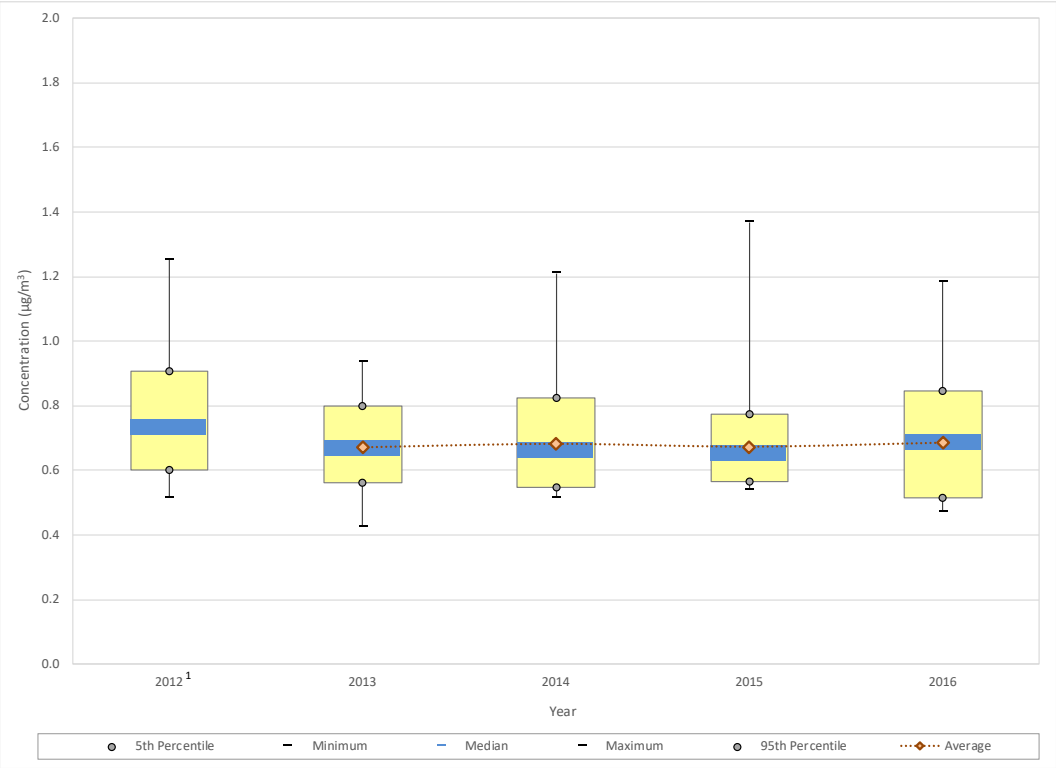
- Three 1,3-butadiene concentrations greater than 0.6 µg/m^3 have been measured at ATKY, one measured each year between 2012 and 2014. The maximum 1,3-butadiene concentration decreased by more than half for 2015 and is at a minimum for 2016, when 1,3-butadiene concentrations greater than 0.2 µg/m^3 were not measured.

- The range of 1,3-butadiene concentrations measured during the first three years of sampling did not vary much. The median concentration did not change from 2012 to 2013, despite twice the number of samples collected and a four-fold increase in the number of non-detects measured (from four to 18).

- The central tendency parameters both exhibit increases for 2014. This is due, at least in part, to fewer non-detects, which decreased by half from 2013 (18) to 2014 (9).

- With the exception of the minimum concentration (which did not change) and the 5th percentile (which increased slightly), the statistical metrics exhibit decreases for 2015; additional decreases are shown for 2016.

Figure 12-49. Yearly Statistical Metrics for Carbon Tetrachloride Concentrations Measured at ATKY



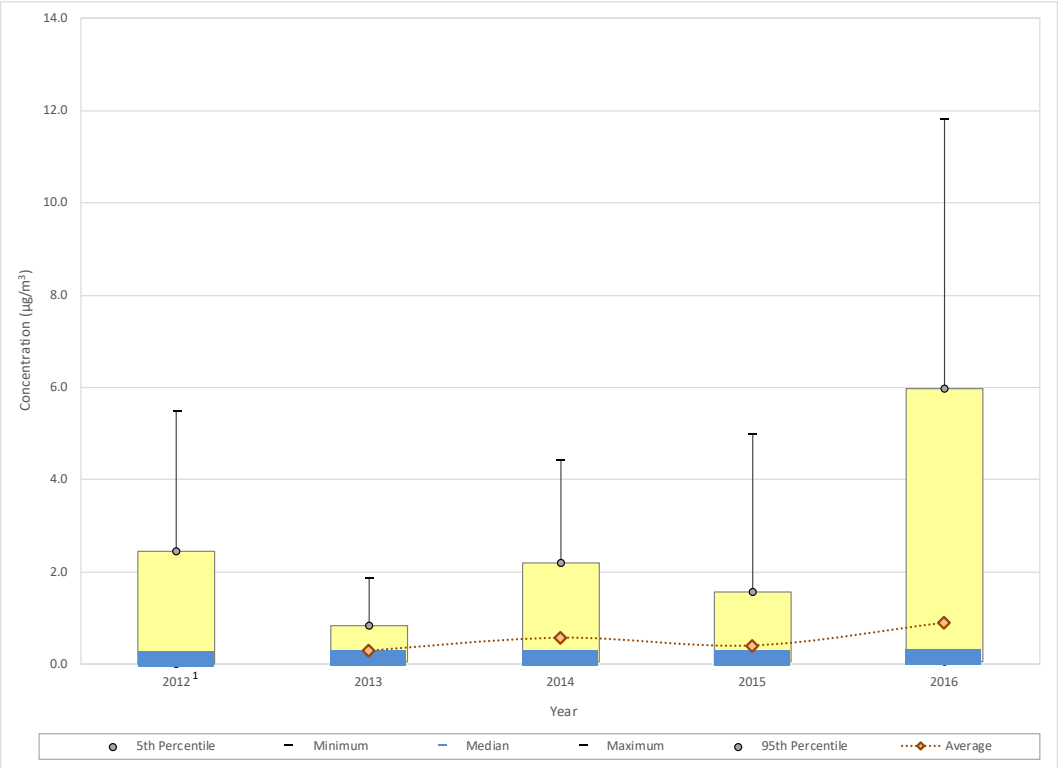
[1] A 1-year average is not presented because consistent sampling under the NMP began in July 2012.

Observations from Figure 12-49 for carbon tetrachloride concentrations measured at ATKY include the following:

- Concentrations of carbon tetrachloride measured at ATKY span less than 1 µg/m^3 across the years of sampling, ranging from 0.43 µg/m^3 (2013) to 1.37 µg/m^3 (2015). The majority of concentrations measured fall into an even tighter range, as indicated by the 5th and 95th percentiles.

- Less than 0.015 µg/m^3 separates the available 1-year average concentrations. The median concentrations vary a little more. The median concentration for 2012 is 0.73 µg/m^3, then decreases to 0.67 µg/m^3 for 2013, which represents the largest year-to-year change in this parameter. The median concentration varies between 0.66 µg/m^3 and 0.69 µg/m^3 for the years between 2013 and 2016. The percentage of carbon tetrachloride concentrations greater than 0.8 µg/m^3 is at a maximum for 2012 (27 percent), accounting for less than 10 percent of measurements in the years that follow.

Figure 12-50. Yearly Statistical Metrics for 1,2-Dichloroethane Concentrations Measured at ATKY



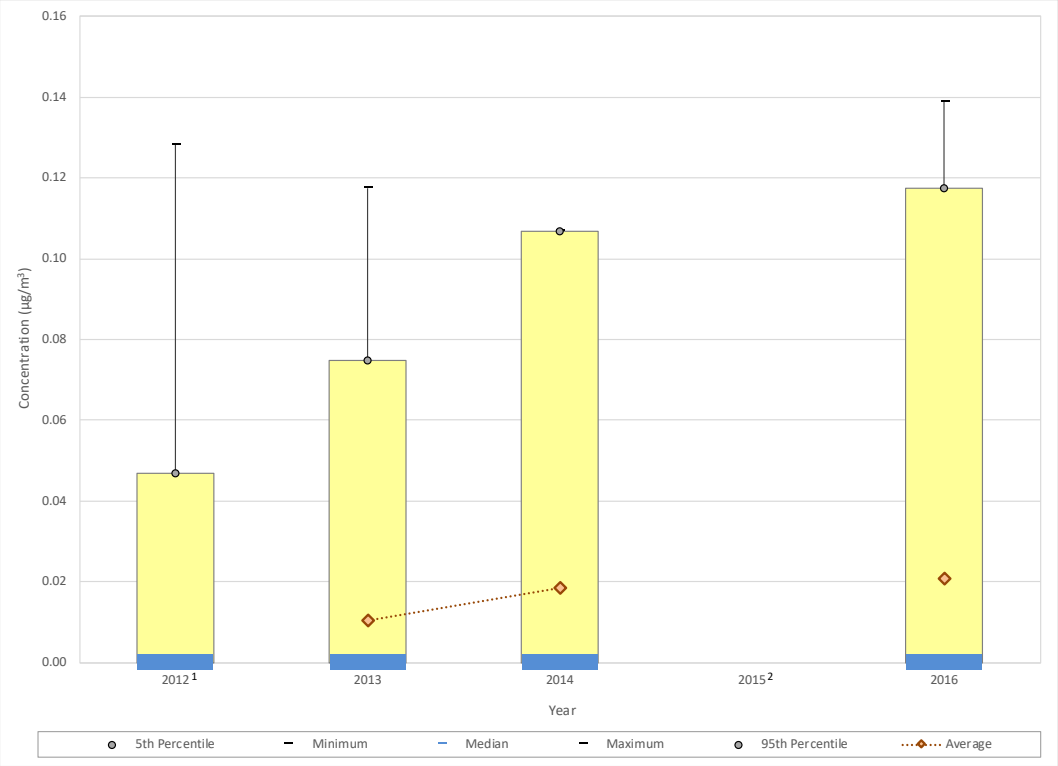
[1] A 1-year average is not presented because consistent sampling under the NMP began in July 2012.

Observations from Figure 12-50 for 1,2-dichloroethane concentrations measured at ATKY include the following:

- Concentrations of 1,2-dichloroethane measured at ATKY are highly variable. With the exception of 2015, at least one non-detect has been measured each year. Measured detections have ranged from 0.049 µg/m^3 to 11.8 µg/m^3. Concentrations greater than 1 µg/m^3 have been measured each year, varying in number from as low as three (2013) to as many as 14 (2014). Yet, the median concentration, or the mid-point of the dataset, for each year is 0.15 µg/m^3 or less.

- The 1-year average concentrations have an undulating pattern, with a year with a "higher" average concentration following a year with a "lower" average. The 1-year average concentrations have ranged from 0.30 µg/m^3 to 0.90 µg/m^3, reaching a maximum for 2016. The four highest 1,2-dichloroethane concentrations measured at ATKY were all measured in 2016 and range from 5.96 µg/m^3 to 11.8 µg/m^3.

Figure 12-51. Yearly Statistical Metrics for Hexachloro-1,3-butadiene Concentrations Measured at ATKY



[1] A 1-year average is not presented because consistent sampling under the NMP began in July 2012.
[2] A 1-year average is not presented due to a laboratory contamination issue affecting numerous samples.

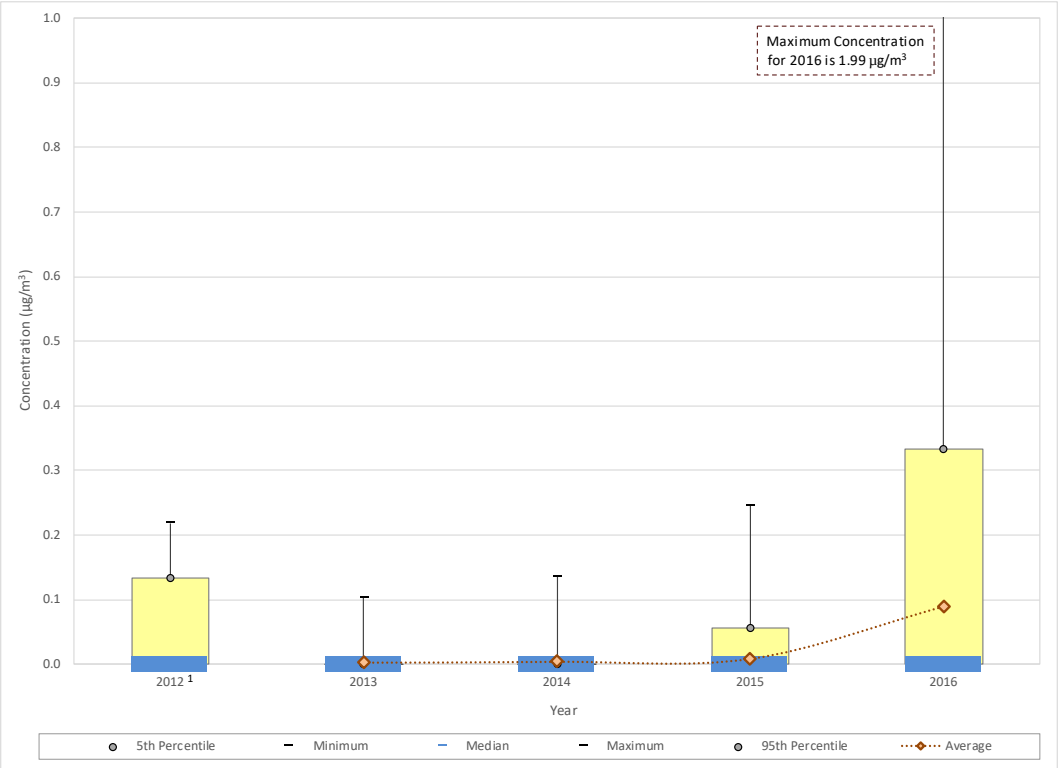
Observations from Figure 12-51 for hexachloro-1,3-butadiene concentrations measured at ATKY include the following:

- The use of a contaminated internal standard at the laboratory for Method TO-15 resulted in the invalidation of the hexachloro-1,3-butadiene measurements from early March 2015 through mid-December 2015, as described in Section 2.4.

- The minimum, 5th percentile, and median concentrations of hexachloro-1,3-butadiene for each year are zero, indicating that at least half of the measurements were non-detects each year. The percentage of non-detects has ranged from 77 percent (2016) to 85 percent (2013), excluding 2015, which was affected by a contamination issue.

- Hexachloro-1,3-butadiene concentrations greater than 0.1 µg/m^3 have been measured each year of sampling at ATKY (except 2015, for which there were only 10 valid samples), with the number increasing over time, from one each year in 2012 and 2013, to four in 2014, to six in 2016.

Figure 12-52. Yearly Statistical Metrics for 1,1,2-Trichloroethane Concentrations Measured at ATKY



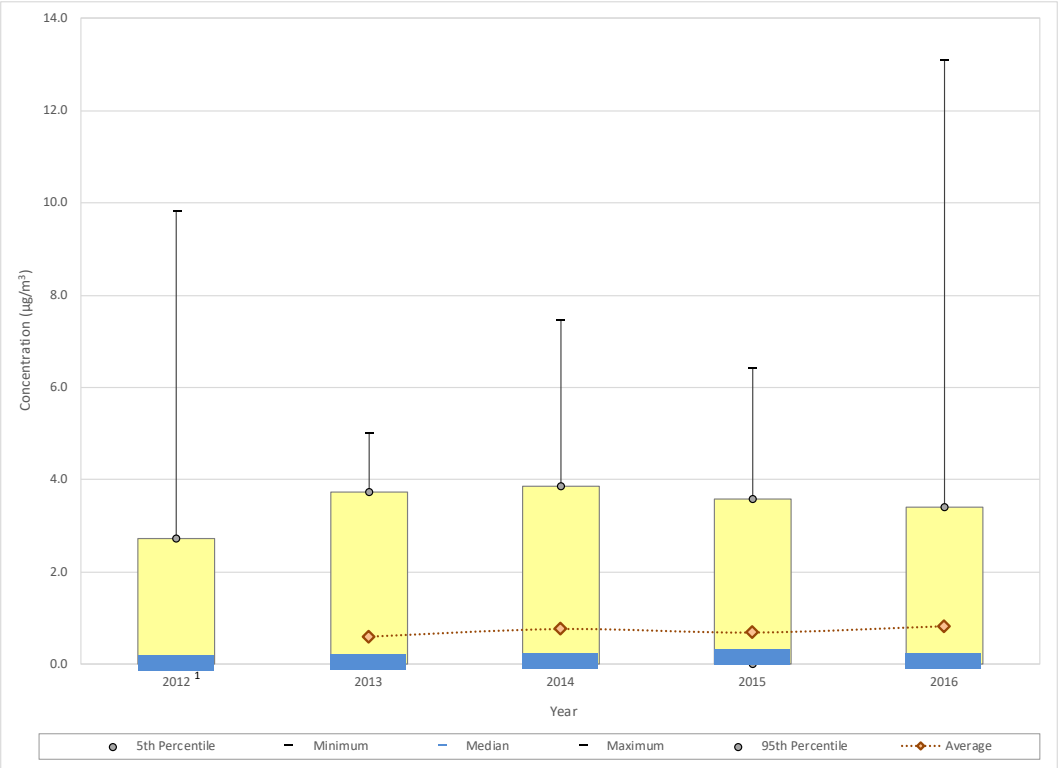
[1] A 1-year average is not presented because consistent sampling under the NMP began in July 2012.

Observations from Figure 12-52 for 1,1,2-trichloroethane concentrations measured at ATKY include the following:

- Similar to hexachloro-1,3-butadiene, the minimum, 5th percentile, and median concentrations of 1,1,2-trichloroethane for ATKY are all zero, indicating that at least half of the measurements were non-detects each year. The percentage of non-detects has ranged from 85 percent (2016) to 97 percent (2013 and 2014), explaining why even the 95th percentile is zero for these two years.

- Not only is the number of non-detects at a minimum for 2016, but the concentrations measured were also higher than in previous years. The five highest 1,1,2-trichloroethane concentrations measured at ATKY were measured in 2016 and range from 0.317 µg/m^3 to 1.99 µg/m^3; this is the only year in which a 1,1,2-trichloroethane concentration greater than 0.3 µg/m^3 has been measured.

Figure 12-53. Yearly Statistical Metrics for Vinyl Chloride Concentrations Measured at ATKY



[1] A 1-year average is not presented because consistent sampling under the NMP began in July 2012.

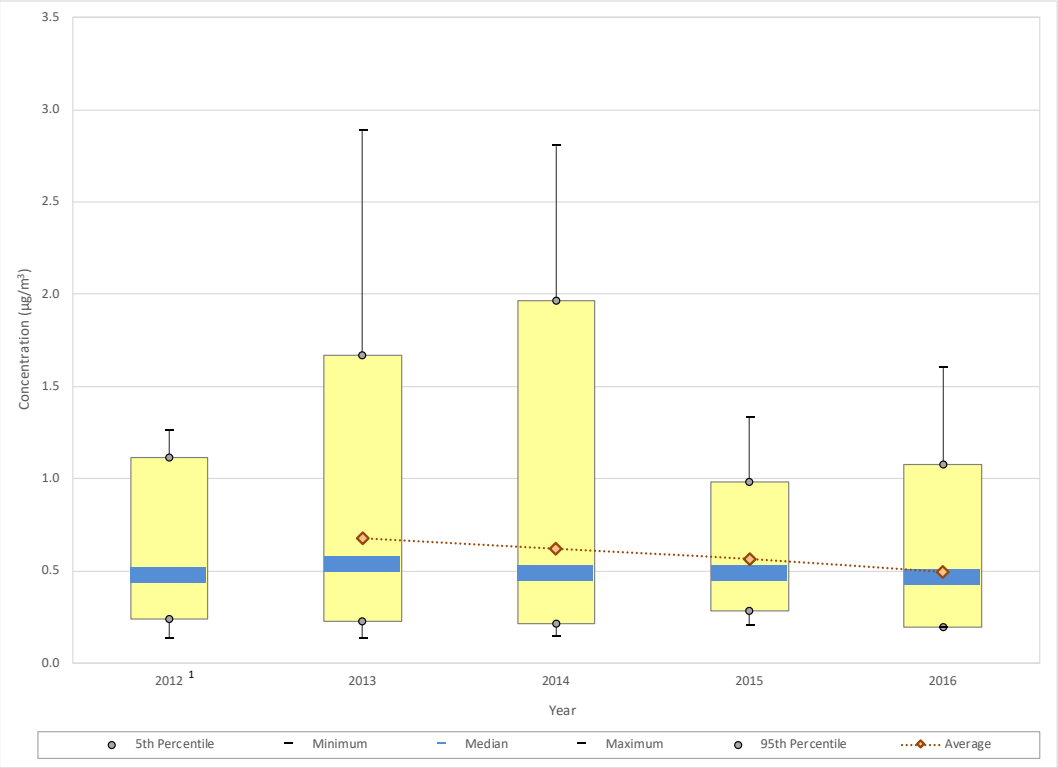
Observations from Figure 12-53 for vinyl chloride concentrations measured at ATKY include the following:

- The minimum concentration and 5th percentile for each year is zero, indicating the presence of non-detects. The percentage of non-detects has ranged from 18 percent (2016) to 42 percent (2012).

- Measured detections have ranged from 0.00256 µg/m^3 to 13.1 µg/m^3, both of which were measured in 2016. Concentrations greater than 1 µg/m^3 account for about 20 percent of the measurements each year, yet, the median concentration, or the mid-point of the dataset, is less than 0.1 µg/m^3 for all years except 2015 (for which the median is 0.15 µg/m^3).

- The 1-year average concentration has varied by less than 0.25 µg/m^3 across the years, ranging from 0.60 µg/m^3 (2013) to 0.83 µg/m^3 (2016).

Figure 12-54. Yearly Statistical Metrics for Benzene Concentrations Measured at BLKY



[1] A 1-year average is not presented because consistent sampling under the NMP began in July 2012.

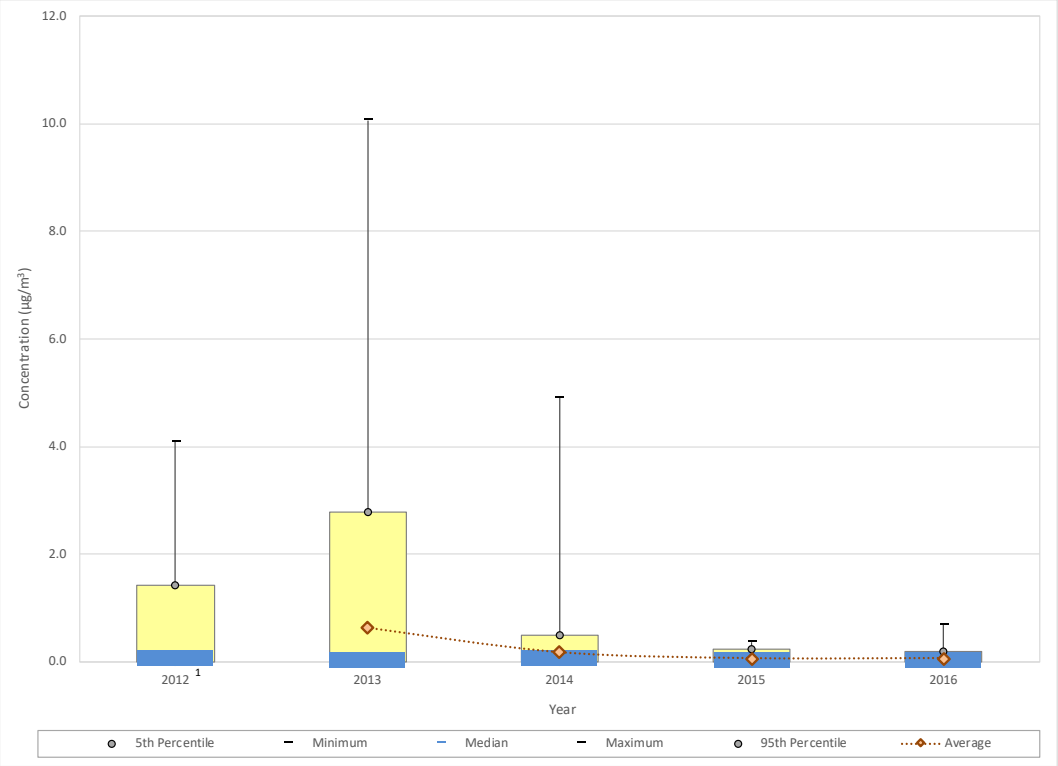
Observations from Figure 12-54 for benzene concentrations measured at BLKY include the following:

- Although sampling for VOCs at BLKY under the NMP began in March 2012, there was a 3-month break in sampling, then sampling resumed in mid-July. Because a full year's worth of data is not available, a 1-year average concentration for 2012 is not presented, although the range of measurements is provided.

- All six benzene concentrations greater than 2 µg/m^3 were measured at BLKY in either 2013 or 2014. Fifteen of the 24 benzene concentrations greater than 1 µg/m^3 were measured during these two years.

- The 1-year average concentration has decreased each year since 2013, decreasing from 0.67 µg/m^3 to 0.49 µg/m^3. However, confidence intervals calculated for these averages indicate that the changes are not statistically significant, mostly due to the relatively large amount of variability in the measurements from 2013 and 2014.

Figure 12-55. Yearly Statistical Metrics for 1,3-Butadiene Concentrations Measured at BLKY



[1] A 1-year average is not presented because consistent sampling under the NMP began in July 2012.

Observations from Figure 12-55 for 1,3-butadiene concentrations measured at BLKY include the following:

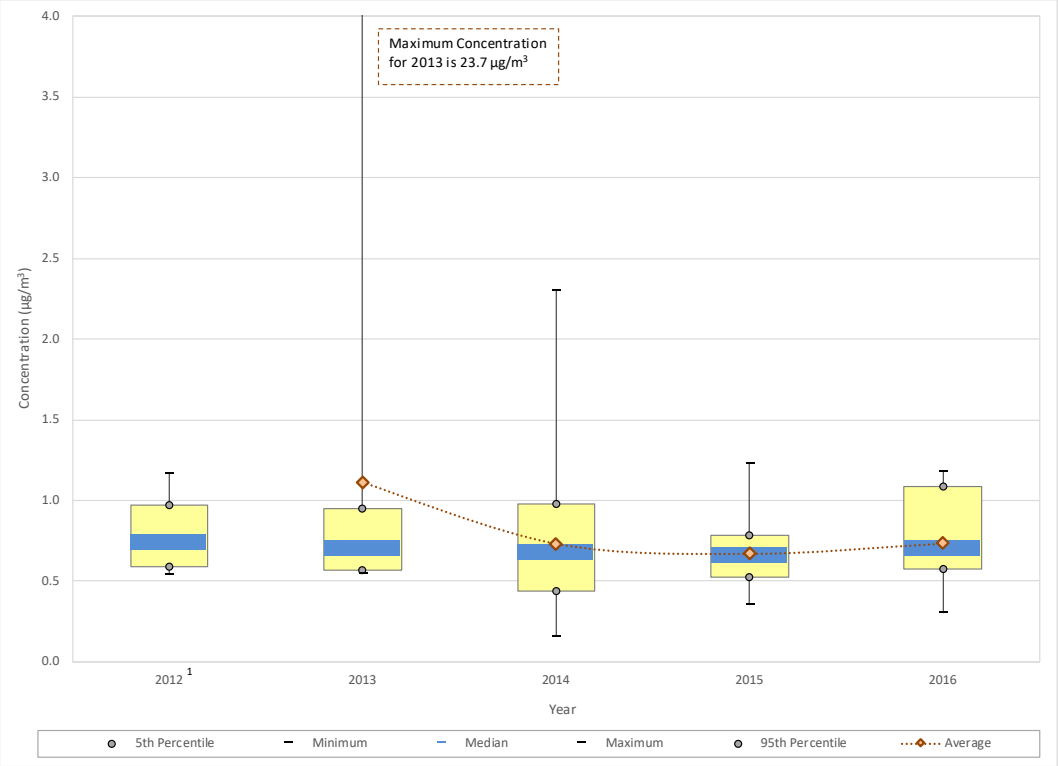
- The minimum concentration and 5th percentile for each year is zero, indicating the presence of non-detects. The percentage of non-detects has ranged from 14 percent (2015) to 36 percent (2013).

- All 11 1,3-butadiene concentrations greater than 1 µg/m^3 were measured at BLKY prior to 2015 (with two measured in 2012, eight in 2013, and one in 2014).

- The 1-year average concentration decreased by an order of magnitude between 2013 and 2016, decreasing from 0.63 µg/m^3 for 2013 to 0.06 µg/m^3 for 2015 and 2016.

- The median concentration, however, has changed little, varying between 0.04 µg/m^3 and 0.05 µg/m^3 across the years of sampling.

Figure 12-56. Yearly Statistical Metrics for Carbon Tetrachloride Concentrations Measured at BLKY



[1] A 1-year average is not presented because consistent sampling under the NMP began in July 2012.

Observations from Figure 12-56 for carbon tetrachloride concentrations measured at BLKY include the following:

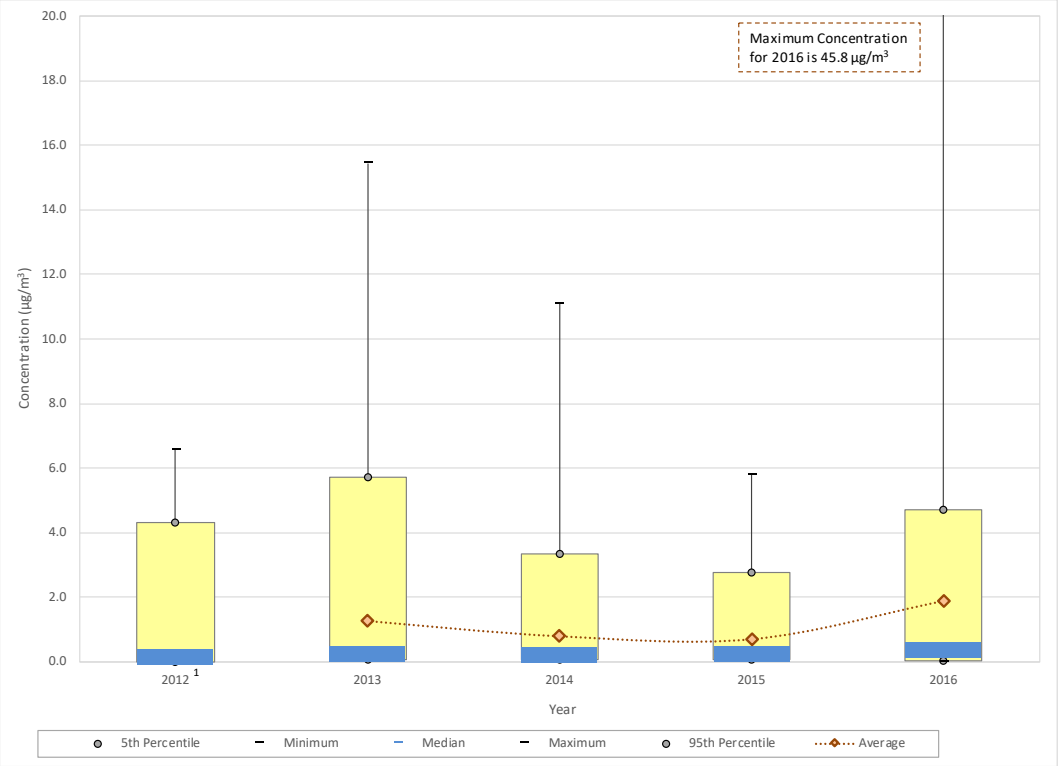
- The maximum carbon tetrachloride concentration was measured at BLKY in 2013 (23.7 µg/m^3) and is an order of magnitude greater than the next highest concentration (2.30 µg/m^3), which was measured in 2014.

- The magnitude of the outlier measured in 2013 is such that the 1-year average concentration calculated for 2013 (1.11 µg/m^3) is greater than the 95th percentile for that year. The median concentration, which is less affected by outliers, for 2013 is 0.70 µg/m^3.

- The median concentration decreased slightly each year through 2015. This is also true for the 1-year average concentration, although the largest change is exhibited between 2013 and 2014. If the maximum concentration was excluded from the dataset, the 1-year average would exhibit virtually no change between 2013 and 2014.

- Both central tendency parameters exhibit increases for 2016. Although the range of concentrations measured exhibits little change from 2015 to 2016, the range within which the majority of concentrations fall, as indicated by the 5th and 95th percentiles, doubles from 2015 to 2016.

Figure 12-57. Yearly Statistical Metrics for 1,2-Dichloroethane Concentrations Measured at BLKY



[1] A 1-year average is not presented because consistent sampling under the NMP began in July 2012.

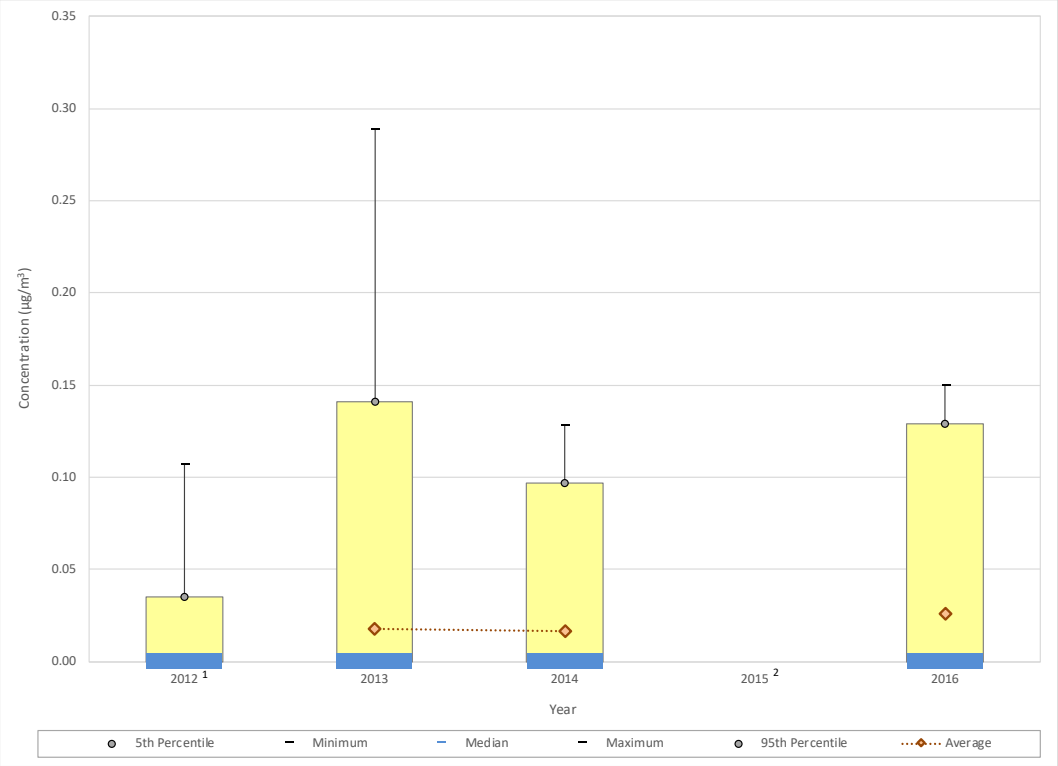
Observations from Figure 12-57 for 1,2-dichloroethane concentrations measured at BLKY include the following:

- Concentrations of 1,2-dichloroethane measured at BLKY are highly variable. Two to three non-detects have been measured each year, with the exception of 2015. Measured detections span three orders of magnitude, ranging from 0.041 µg/m^3 to 45.8 µg/m^3. Concentrations greater than 5 µg/m^3 have been measured each year, varying in number from as few as one (2012 and 2015) to as many as six (2013). At the other end of the concentration range, multiple concentrations less than 0.05 µg/m^3 have also been measured each year, varying in number from two (2015) to five (2012).

- Although difficult to discern in Figure 12-57, the median concentration has varied by less than 0.25 µg/m^3 over the years of sampling, ranging from 0.13 µg/m^3 (2012) to 0.33 µg/m^3 (2016).

- The 1-year average concentration decreases somewhat between 2013 and 2015, before increasing considerably for 2016. Even if the maximum concentration measured in 2016 was excluded from the dataset, the 1-year average concentration for 2016 would still exhibit an increase.

Figure 12-58. Yearly Statistical Metrics for Hexachloro-1,3-butadiene Concentrations Measured at BLKY



[1] A 1-year average is not presented because consistent sampling under the NMP began in July 2012.
[2] A 1-year average is not presented due to a laboratory contamination issue affecting numerous samples.

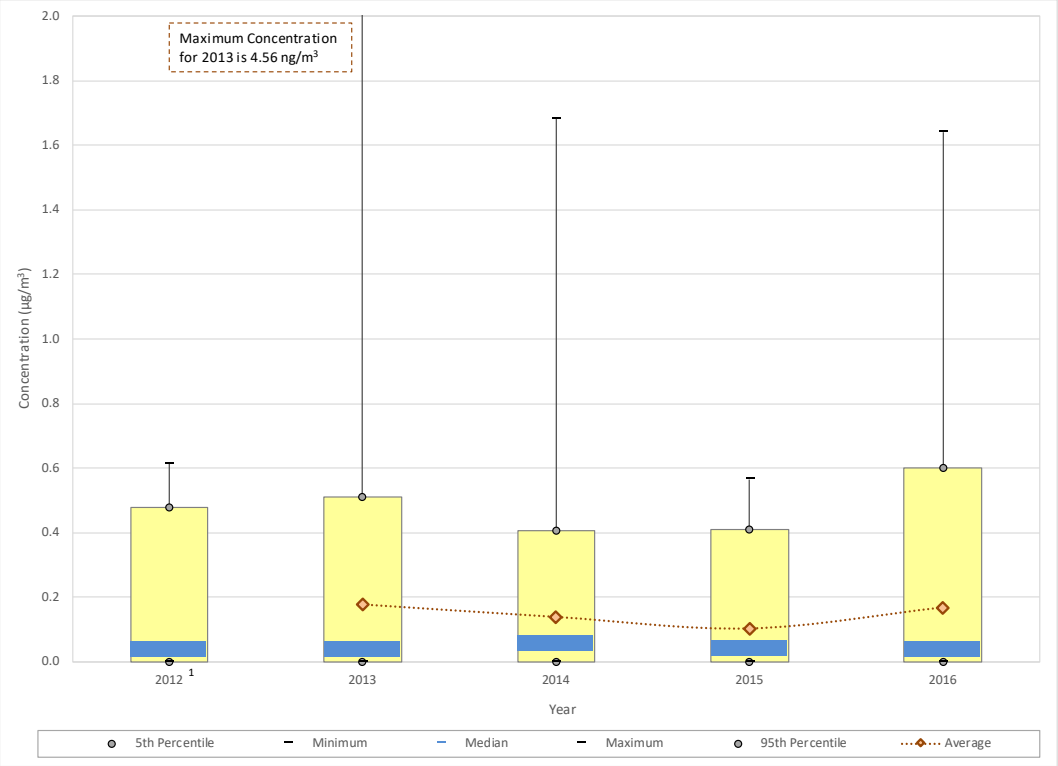
Observations from Figure 12-58 for hexachloro-1,3-butadiene concentrations measured at BLKY include the following:

- The use of a contaminated internal standard at the laboratory for Method TO-15 resulted in the invalidation of the hexachloro-1,3-butadiene measurements from early March 2015 through mid-December 2015, as described in Section 2.4.

- The minimum, 5th percentile, and median concentrations of hexachloro-1,3-butadiene for BLKY are zero for all years of sampling except 2015, indicating that at least half of the measurements were non-detects each year. Excluding 2015, the percentage of non-detects has ranged from 72 percent (2016) to 93 percent (2012).

- The maximum hexachloro-1,3-butadiene concentration (0.29 µg/m^3) was measured in 2013, along with the two other concentrations greater than 0.15 µg/m^3. Concentrations greater than 0.1 µg/m^3 have been measured each year of sampling at BLKY except 2015, with the number varying from one (2012) to seven (2016).

Figure 12-59. Yearly Statistical Metrics for Vinyl Chloride Concentrations Measured at BLKY



[1] A 1-year average is not presented because consistent sampling under the NMP began in July 2012.

Observations from Figure 12-59 for vinyl chloride concentrations measured at BLKY include the following:

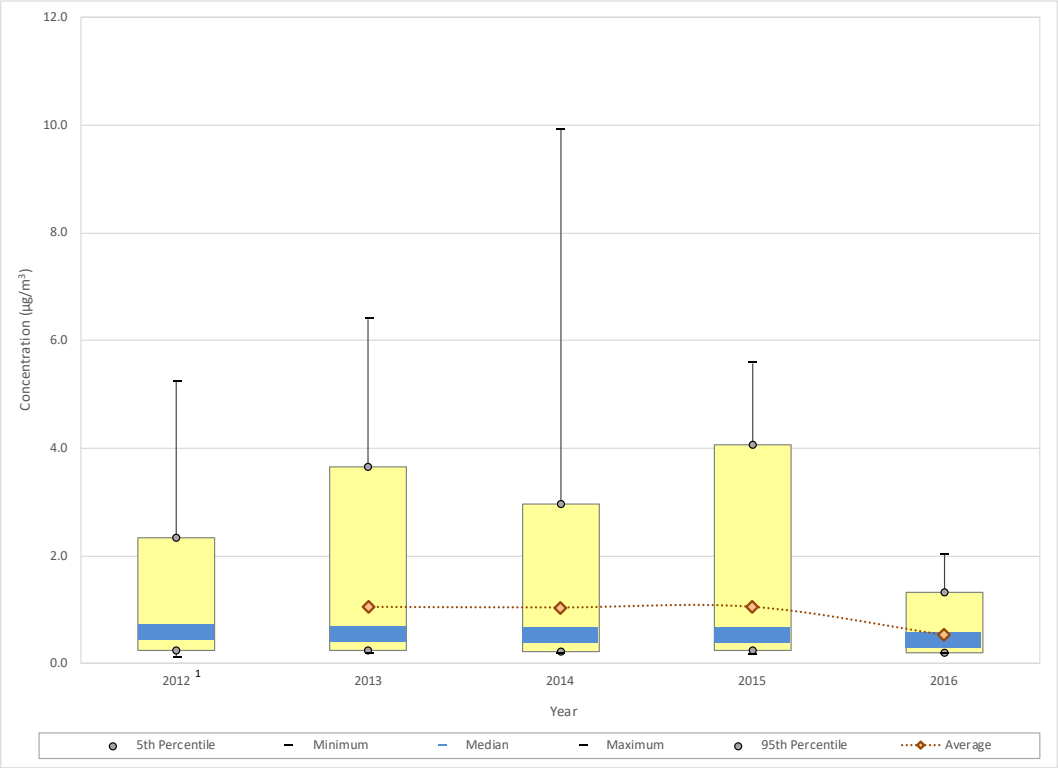
- The minimum concentration and 5th percentile for each year is zero, indicating the presence of non-detects. The percentage of non-detects was greater than 40 percent for each of the first three years, decreased to 31 percent for 2015 and to 22 percent for 2016.

- Measured detections have ranged from 0.00256 µg/m^3 to 4.56 µg/m^3; the maximum vinyl chloride concentration measured at BLKY is three times greater than the next highest concentration measured at this site (1.68 µg/m^3). In total, six concentrations greater than 1 µg/m^3 have been measured at BLKY since 2012.

- The median concentration is approximately 0.04 µg/m^3 for all years except 2014, for which the median is 0.06 µg/m^3.

- The 1-year average concentration decreases slightly between 2013 and 2015, before returning to near-2013 levels for 2016. The 1-year average concentration has varied by less than 0.25 µg/m^3 across the years, ranging from 0.60 µg/m^3 to 0.83 µg/m^3, reaching a maximum for 2016.

Figure 12-60. Yearly Statistical Metrics for Benzene Concentrations Measured at TVKY



[1] A 1-year average is not presented because consistent sampling under the NMP began in July 2012.

Observations from Figure 12-60 for benzene concentrations measured at TVKY include the following:

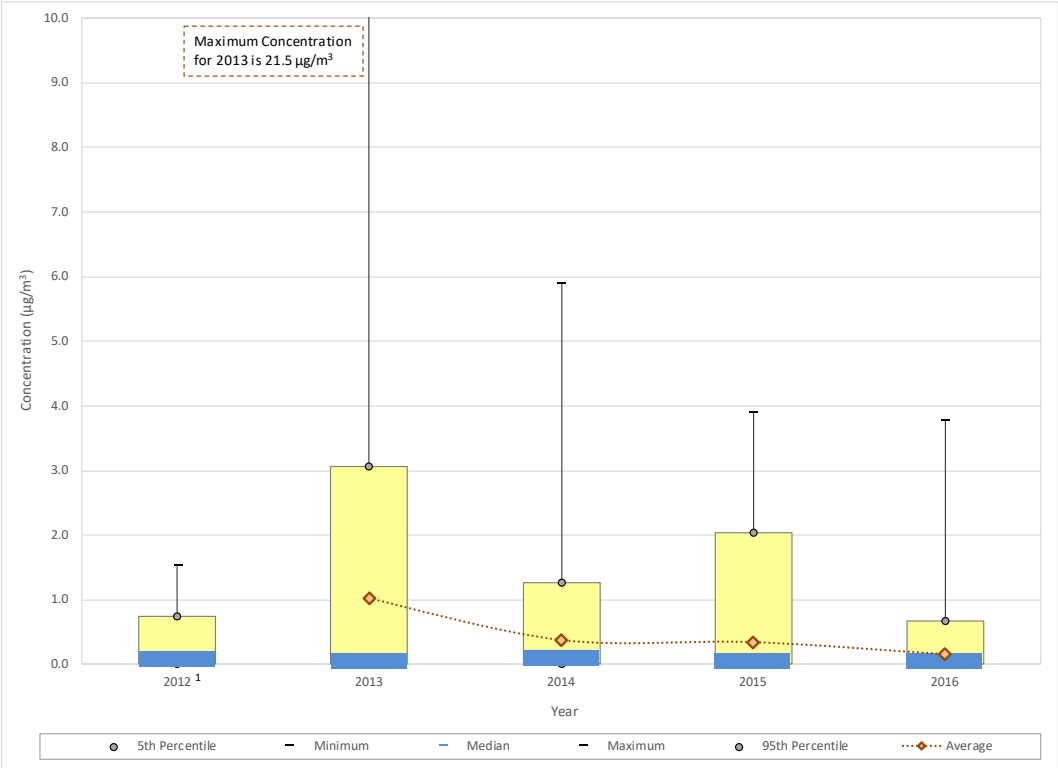
- Although sampling for VOCs at TVKY under the NMP began in March 2012, there was a 3-month break in sampling, then sampling resumed in mid-July. Because a full year's worth of data is not available, a 1-year average concentration for 2012 is not presented, although the range of measurements is provided.

- The maximum concentration of benzene was measured at TVKY in 2014 (9.92 µg/m^3). In total, six benzene concentrations greater than 5 µg/m^3 have been measured at TVKY.

- Despite fluctuations in the concentrations at the upper end of the concentration range, the central tendency parameters exhibit little change across the first four years of sampling. During this time, the 1-year average concentration varied between 1 µg/m^3 and 1.05 µg/m^3 and the median concentration varied between 0.50 µg/m^3 and 0.60 µg/m^3.

- A significant decrease in the magnitude of benzene concentrations is shown for 2016. The maximum concentration measured in 2016 (2.03 µg/m^3) is considerably less than the maximum concentration measured for each of the other years, and is also less than the 95th percentile for each of the previous years. The 1-year average concentration decreased by half from 2015 to 2016.

Figure 12-61. Yearly Statistical Metrics for 1,3-Butadiene Concentrations Measured at TVKY



[1] A 1-year average is not presented because consistent sampling under the NMP began in July 2012.

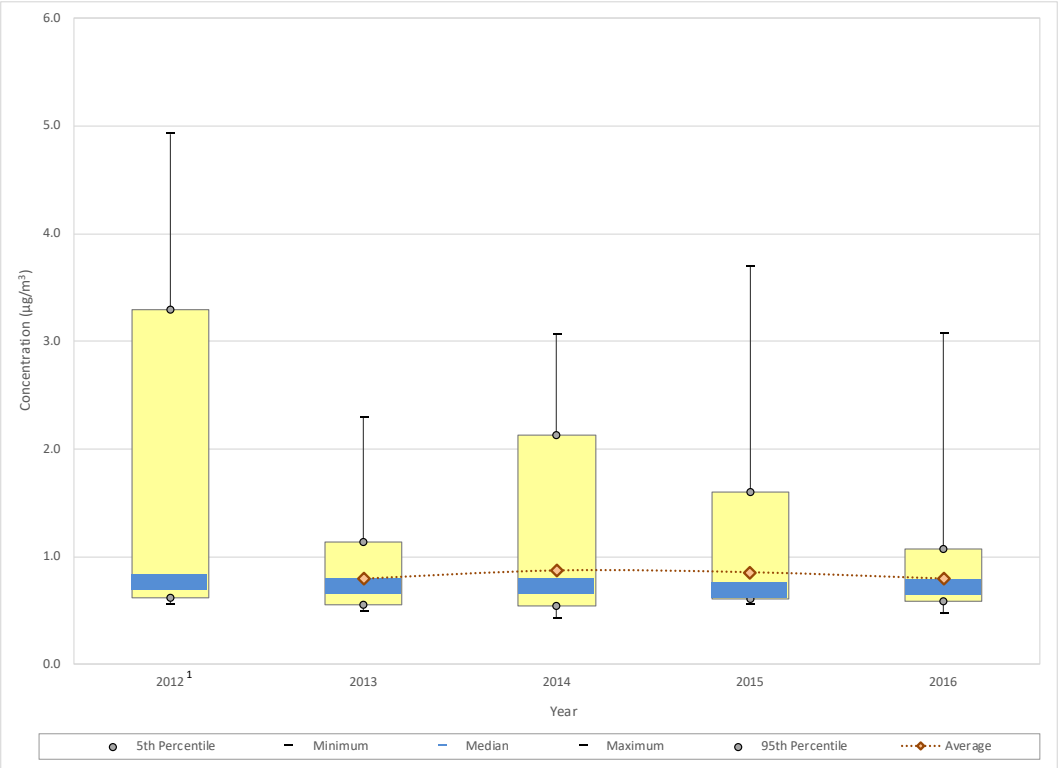
Observations from Figure 12-61 for 1,3-butadiene concentrations measured at TVKY include the following:

- The maximum concentration of 1,3-butadiene was measured at TVKY in October 2013 (21.5 µg/m^3), although a concentration of similar magnitude was also measured a few months earlier (20.8 µg/m^3). These are the only two 1,3-butadiene concentrations greater than 6 µg/m^3 measured at this site.

- The median concentration is less than 0.1 µg/m^3 for all years of sampling, indicating that at least half of the measurements collected each year are less than this (including non-detects).

- The 1-year average concentration has decreased each year since 2013, decreasing from a maximum of 1.03 µg/m^3 for 2013 to a minimum of 0.16 µg/m^3 for 2016. However, the confidence intervals associated with these averages are considerably large, indicating such a large amount of variability in the measurements for all years of sampling.

Figure 12-62. Yearly Statistical Metrics for Carbon Tetrachloride Concentrations Measured at TVKY



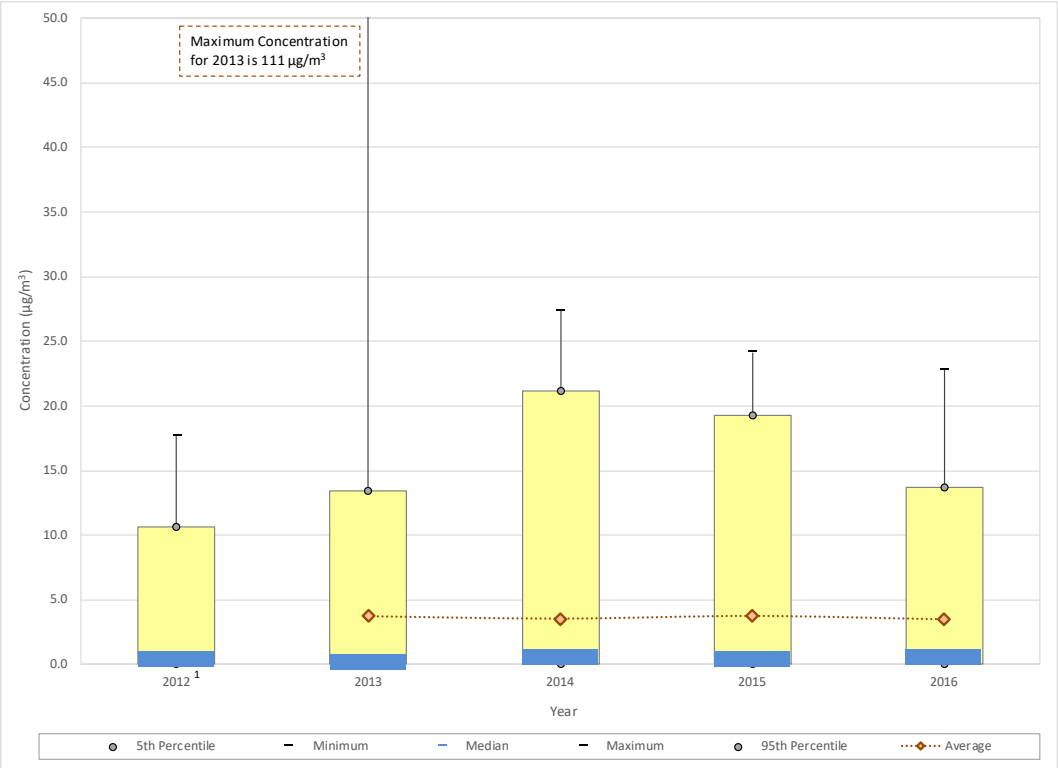
[1] A 1-year average is not presented because consistent sampling under the NMP began in July 2012.

Observations from Figure 12-62 for carbon tetrachloride concentrations measured at TVKY include the following:

- The two highest carbon tetrachloride concentrations measured at TVKY were both measured in 2012 and are the only measurements greater than 4 µg/m^3. Between two and four carbon tetrachloride concentrations greater than 2 µg/m^3 have been measured at this site each year of sampling, for a total of 14.

- Despite fluctuations in the concentrations at the upper end of the concentration range, the central tendency parameters exhibit little change across the years of sampling (less than 0.1 µg/m^3 separates them). During this time, the 1-year average concentration has varied between 0.79 µg/m^3 (2013) and 0.87 µg/m^3 (2014) and the median concentration has varied between 0.69 µg/m^3 (2015) and 0.77 µg/m^3 (2012).

Figure 12-63. Yearly Statistical Metrics for 1,2-Dichloroethane Concentrations Measured at TVKY



[1] A 1-year average is not presented because consistent sampling under the NMP began in July 2012.

Observations from Figure 12-63 for 1,2-dichloroethane concentrations measured at TVKY include the following:

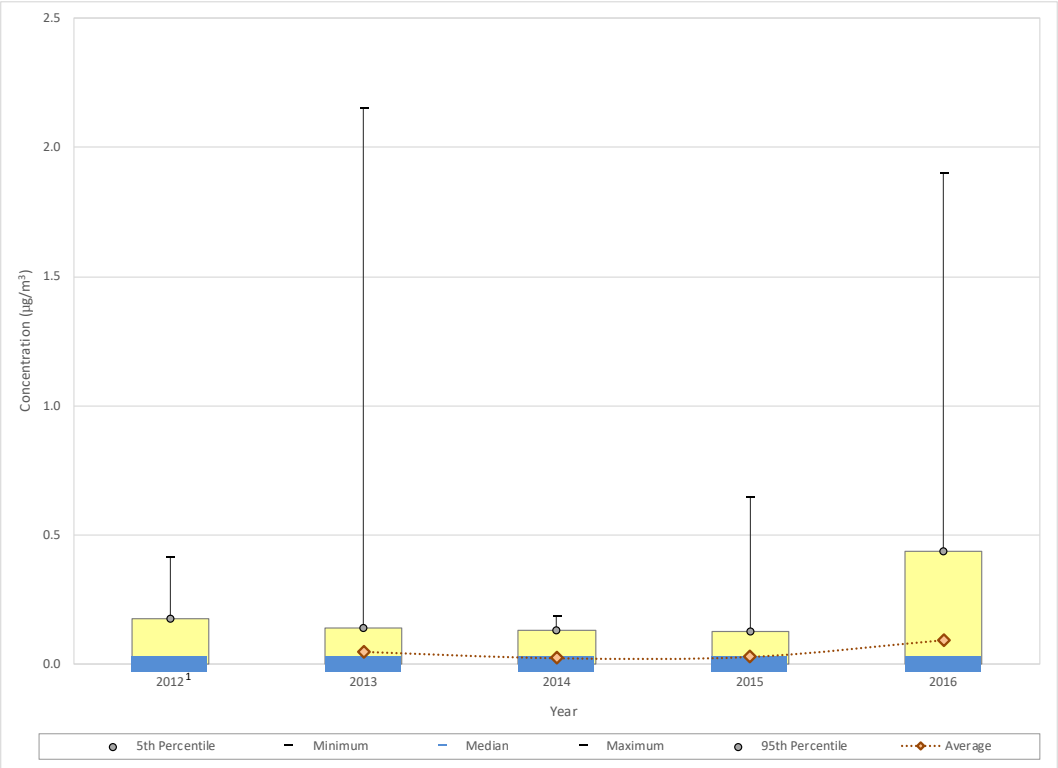
- Concentrations of 1,2-dichloroethane are the most variable among TVKY's pollutants of interest. Measured detections of 1,2-dichloroethane span four orders of magnitude, ranging from 0.0385 µg/m^3 to 111 µg/m^3.

- The maximum 1,2-dichloroethane concentration measured at TVKY in 2013 is four times higher than the next highest 1,2-dichloroethane concentration measured at this site (27.4 µg/m^3). While the maximum concentration measured is an obvious outlier, higher 1,2-dichloroethane concentrations are not an anomaly at this site; 1,2-dichloroethane concentrations greater than 10 µg/m^3 have been measured during each year of sampling, from as few as two (2012) to as many as 10 (2015).

- Despite the considerable fluctuations in the concentrations at the upper end of the concentration range, the central tendency parameters exhibit relatively little change across the years of sampling. During this time, the 1-year average concentration has varied by just over 0.25 µg/m^3, ranging between 3.49 µg/m^3 (2016) and 3.75 µg/m^3 (2015).

- The median concentration calculated for each year is an order of magnitude less than the 1-year average concentration for each year, varying between 0.22 µg/m^3 (2015) and 0.58 µg/m^3 (2012).

Figure 12-64. Yearly Statistical Metrics for 1,1,2-Trichloroethane Concentrations Measured at TVKY



[1] A 1-year average is not presented because consistent sampling under the NMP began in July 2012.

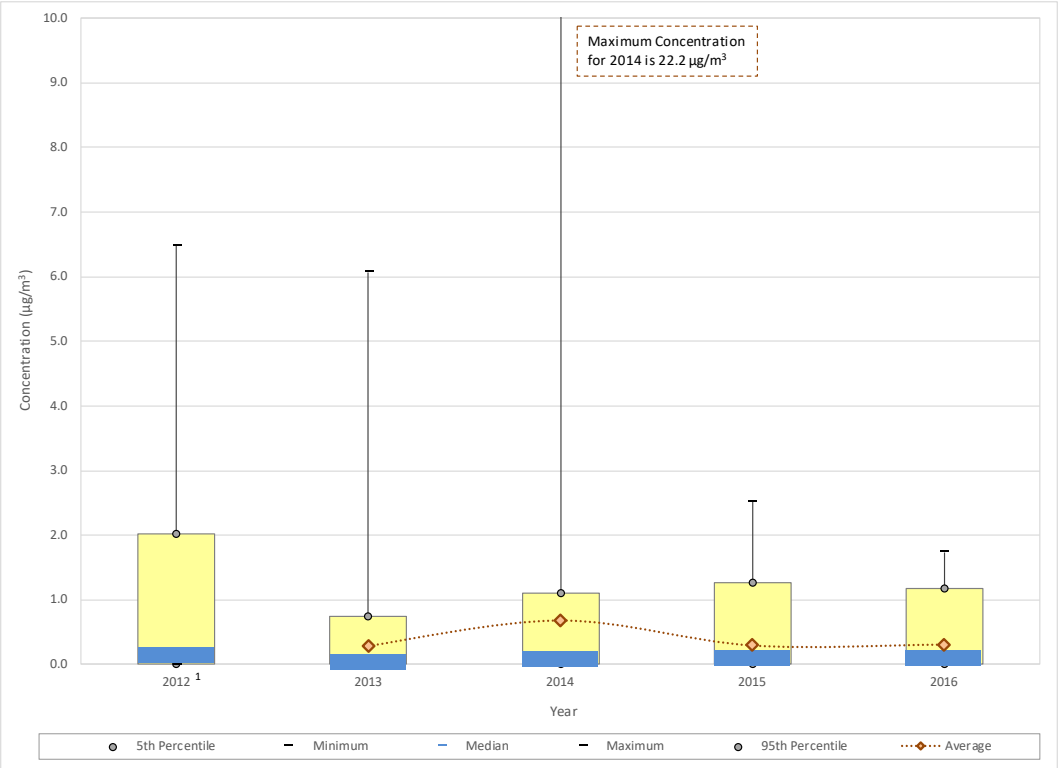
Observations from Figure 12-64 for 1,1,2-trichloroethane concentrations measured at TVKY include the following:

- Three 1,1,2-trichloroethane concentrations greater than 1 µg/m^3 have been measured at TVKY; one in 2013 (2.15 µg/m^3) and two in 2016 (1.90 µg/m^3 and 1.06 µg/m^3). All other 1,1,2-trichloroethane concentrations measured at TVKY are less than 0.65 µg/m^3 and most are less than 0.45 µg/m^3.

- The minimum, 5th percentile, and median concentrations of 1,1,2-trichloroethane for TVKY are zero for all years of sampling, indicating that at least half of the measurements were non-detects each year. The percentage of non-detects has ranged from 72 percent (2016) to 87 percent (2013).

- The 1-year average concentration decreased slightly from 2013 to 2014, changed little for 2015, then increased by a factor of three for 2016. With the percentage of non-detects at a minimum, the 95th percentile at a maximum, and the two of the three highest concentrations measured, this increase is not surprising. The number of 1,1,2-trichloroethane concentrations greater than 0.1 µg/m^3 is also at a maximum (11) for 2016.

Figure 12-65. Yearly Statistical Metrics for Vinyl Chloride Concentrations Measured at TVKY



[1] A 1-year average is not presented because consistent sampling under the NMP began in July 2012.

Observations from Figure 12-65 for vinyl chloride concentrations measured at TVKY include the following:

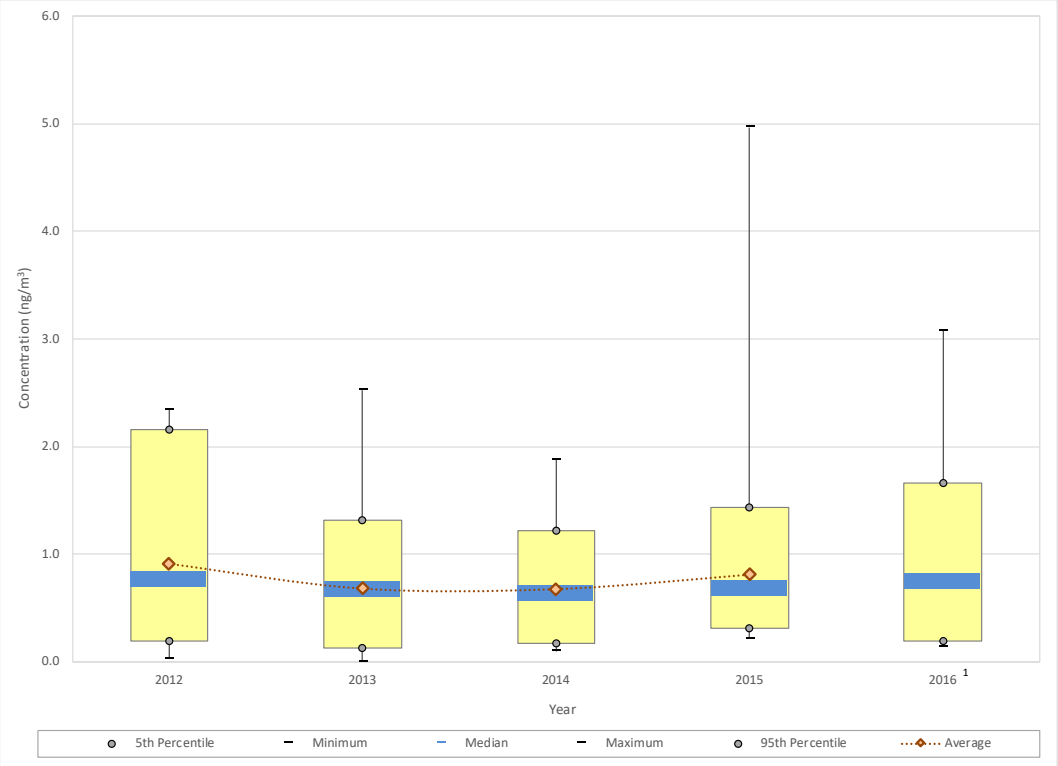
- The minimum concentration and 5th percentile for each year is zero, indicating the presence of non-detects. The percentage of non-detects increased from 31 percent to 42 percent between 2012 and 2013, then decreased each year after, reaching a minimum of 13 percent in 2016.

- Measured detections have ranged from 0.00512 µg/m^3 to 22.2 µg/m^3; the maximum vinyl chloride concentration measured at TVKY is nearly four times greater than the next highest concentration measured at this site (6.49 µg/m^3). Vinyl chloride concentrations greater than 2 µg/m^3 have been measured each year of sampling except 2016.

- The median concentration decreased by more than 70 percent from 2012 to 2013, from 0.14 µg/m^3 to 0.04 µg/m^3, although this is difficult to see in Figure 12-65. This is followed by an increase each year through 2015, such that the median concentration approaches 0.10 µg/m^3 again for 2015 (and is unchanged for 2016).

- Although the 1-year average concentration doubles between 2013 and 2014, if the maximum concentration was excluded from the calculation, the 1-year average would change little among the years of sampling, with each approximately 0.30 µg/m^3; thus, the increase shown for 2014 is attributable to the outlier measured that year.

Figure 12-66. Yearly Statistical Metrics for Arsenic (PM_{10}) Concentrations Measured at LEKY



[1] A 1-year average is not presented because the completeness criteria were not met for 2016.

Observations from Figure 12-66 for arsenic (PM_{10}) concentrations measured at LEKY include the following:

- The two highest arsenic concentrations measured LEKY were measured one month apart (4.97 ng/m^3, December 2015 and 3.08 ng/m^3, January 2016).

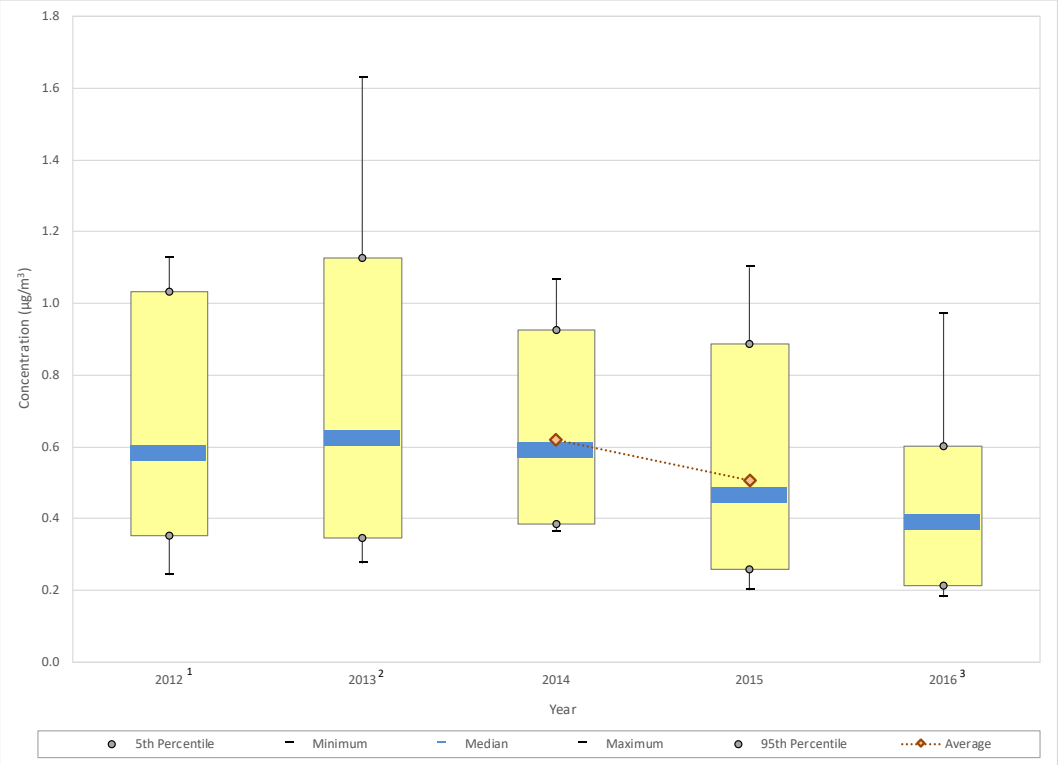
- The 95th percentile for 2012 is at a maximum across the years of sampling; this is also true for the 1-year average (0.92 ng/m^3) and median (0.76 ng/m^3) concentrations. The number of arsenic concentrations greater than 1 ng/m^3 is at a maximum for 2012, accounting for more than one-third of the measurements, which decreases by almost half for the following year.

- The sole non-detect of arsenic was measured in 2013. This, combined nearly twice the number of arsenic concentrations less than 0.25 ng/m^3, along with fewer arsenic concentrations at the upper end of the concentration range, helps explain the decrease in the 1-year average concentration shown for 2013. Little change is shown in the concentration profile for 2014.

- All of the statistical parameters exhibit an increase from 2014 to 2015. While some of this is related to the maximum concentration measured that year, it is not the only reason. The minimum concentration increased two-fold from 2014 to 2015; the 5th percentile exhibits a similar increase. The number of arsenic concentrations less than 0.3 ng/m^3 decreased from 12 in 2014 to two in 2015.

- A 1-year average concentration for 2016 is not provided because the completeness criteria were not met; a number of metals samples collected at LEKY in March and April 2016 had QA-related issues according to the state of Kentucky, which combined with additional invalid samples throughout the year, resulted in a completes of 77 percent. The median concentration for 2016 exhibits an increase, returning to near 2012-levels.

Figure 12-67. Yearly Statistical Metrics for Benzene Concentrations Measured at LEKY



[1] A 1-year average is not presented because consistent sampling under the NMP began in July 2012.
[2] A 1-year average is not presented as collection system issues were experienced in 2013.
[3] A 1-year average is not presented because sampling was discontinued at the end of July 2016.

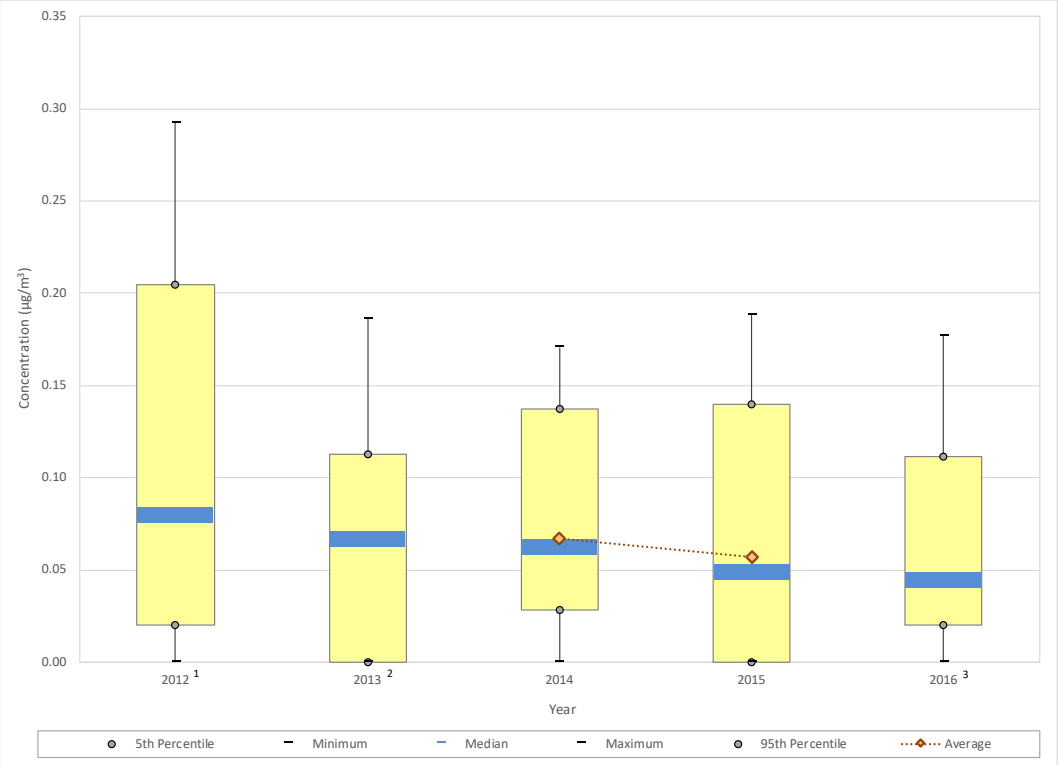
Observations from Figure 12-67 for benzene concentrations measured at LEKY include the following:

- Although sampling for VOCs at LEKY under the NMP began in March 2012, there was a 3-month break in sampling, then sampling resumed in mid-July. Because a full year's worth of data is not available, a 1-year average concentration for 2012 is not presented, although the range of measurements is provided. Issues with the collection system experienced during the first half of 2013 resulted in the invalidation of most samples collected between February and April; thus, a 1-year average concentration for 2013 is not presented. Finally, a 1-year average concentration is not presented for 2016 because VOC sampling was discontinued at the end of July.

- Seven of the 13 benzene concentrations greater than 1 µg/m^3 measured at LEKY were measured in 2013, including the maximum concentration (1.63 µg/m^3).

- Concentrations of benzene appear to have a decreasing trend at LEKY after 2013. The median benzene concentration increased slightly from 2012 to 2013, then decreased each year after, reaching a minimum of 0.39 µg/m^3 for 2016. 2016 is the first year a benzene concentration greater than 1 µg/m^3 is not measured, although the concentration profile for 2016 represents only seven months of sampling.

Figure 12-68. Yearly Statistical Metrics for 1,3-Butadiene Concentrations Measured at LEKY



[1] A 1-year average is not presented because consistent sampling under the NMP began in July 2012.
[2] A 1-year average is not presented as collection system issues were experienced in 2013.
[3] A 1-year average is not presented because sampling was discontinued at the end of July 2016.

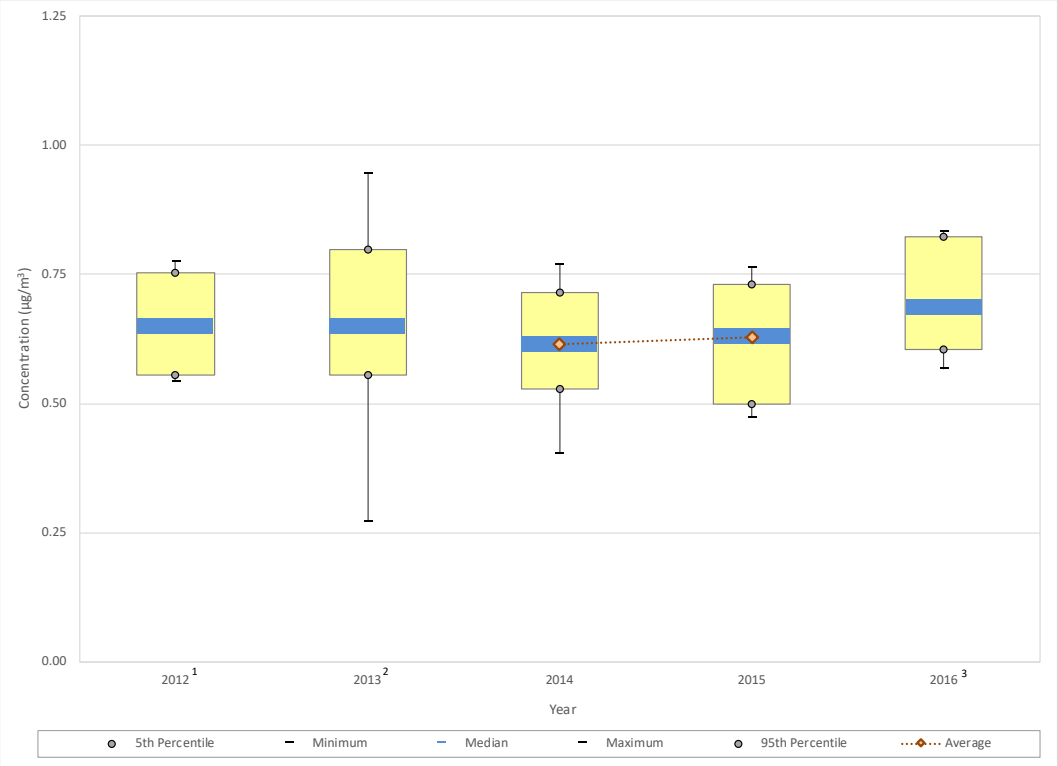
Observations from Figure 12-68 for 1,3-butadiene concentrations measured at LEKY include the following:

- The six highest 1,3-butadiene concentrations were all measured at LEKY in 2012. Concentrations greater than 0.20 µg/m^3 have not been measured in the years since.

- Each of the statistical parameters shown (with the exception of the minimum concentration, which did not change) exhibits a decrease between 2012 and 2013.

- Although the range of concentrations measured is fairly consistent, concentrations of 1,3-butadiene also appear to have a decreasing trend at this site. The median concentration has decreased by nearly half between 2012 and 2016, decreasing from 0.08 µg/m^3 to 0.04 µg/m^3 during the period of sampling.

Figure 12-69. Yearly Statistical Metrics for Carbon Tetrachloride Concentrations Measured at LEKY



[1] A 1-year average is not presented because consistent sampling under the NMP began in July 2012.
[2] A 1-year average is not presented as collection system issues were experienced in 2013.
[3] A 1-year average is not presented because sampling was discontinued at the end of July 2016.

Observations from Figure 12-69 for carbon tetrachloride concentrations measured at LEKY include the following:

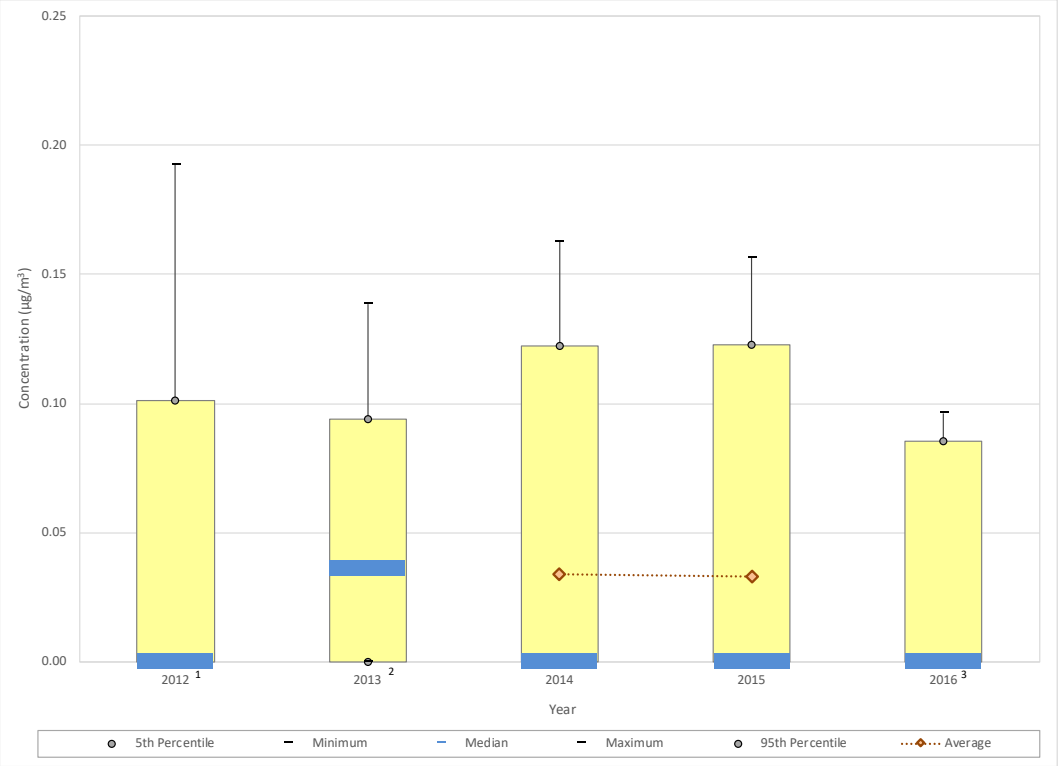
- The entire range of carbon tetrachloride concentrations measured at LEKY spans less than 0.75 µg/m^3. If the minimum and maximum concentrations measured in 2013 are excluded, the entire range would vary by less than 0.45 µg/m^3.

- Seven carbon tetrachloride concentrations greater than 0.8 µg/m^3 were measured at LEKY, all of which were measured in either 2013 (three) or 2016 (four).

- Despite the difference in the range of concentrations measured, the median concentration for 2012 is the same as the median concentration for 2013 (0.65 µg/m^3). Between 2012 and 2015, the median concentration varies by less than 0.04 µg/m^3, ranging from 0.61 µg/m^3 (2014) to 0.65 µg/m^3 (2012, 2013).

- All of the statistical parameters exhibit an increase for 2016, with several at a maximum over the period of sampling. Four carbon tetrachloride concentrations measured in 2016 are greater than the maximum concentration measured in 2015 (also true for 2014). At the other end of the concentration range, only one carbon tetrachloride concentrations less than 0.6 µg/m^3 was measured in 2016, compared to 17 for 2015 (and 22 for 2014).

Figure 12-70. Yearly Statistical Metrics for *p*-Dichlorobenzene Concentrations Measured at LEKY



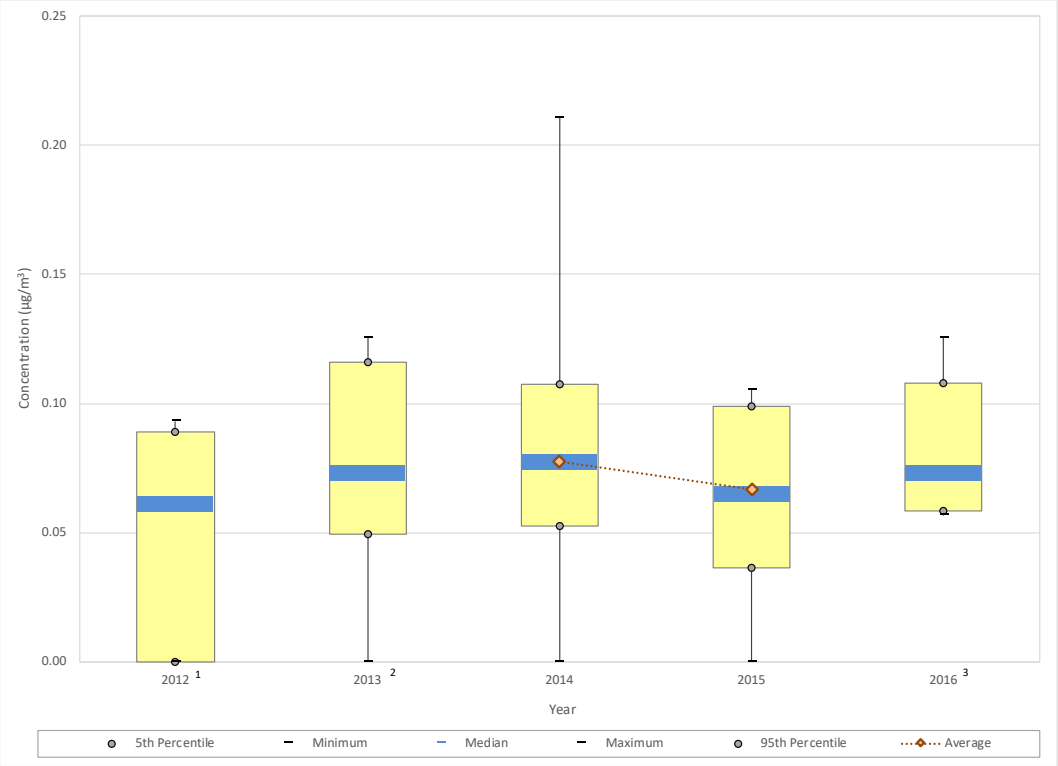
[1] A 1-year average is not presented because consistent sampling under the NMP began in July 2012.
[2] A 1-year average is not presented as collection system issues were experienced in 2013.
[3] A 1-year average is not presented because sampling was discontinued at the end of July 2016.

Observations from Figure 12-70 for *p*-dichlorobenzene concentrations measured at LEKY include the following:

- With the exception of 2013, non-detects account for more than half of the *p*-dichlorobenzene measurements collected at this site each year, as the minimum, 5th percentile, and median concentration (for most years) are zero. For 2013, non-detects account for less than 40 percent of the measurements.

- Although it appears that there is considerable variation in the upper end of the concentrations measured, the relatively small scale of Figure 12-70 should be noted. Less than 0.1 µg/m^3 separates the maximum concentrations measured across the years of sampling and less than 0.04 µg/m^3 separates the 95th percentiles shown.

Figure 12-71. Yearly Statistical Metrics for 1,2-Dichloroethane Concentrations Measured at LEKY



[1] A 1-year average is not presented because consistent sampling under the NMP began in July 2012.
[2] A 1-year average is not presented as collection system issues were experienced in 2013.
[3] A 1-year average is not presented because sampling was discontinued at the end of July 2016.

Observations from Figure 12-71 for 1,2-dichloroethane concentrations measured at LEKY include the following:

- The number of non-detects is at a maximum for 2012 (five). Two or fewer non-detects were measured between 2013 and 2015, with none measured in 2016.

- The maximum 1,2-dichloroethane concentration was measured in 2014 (0.211 µg/m^3). The maximum concentration for the remaining years falls within a relatively tight range, between 0.09 µg/m^3 and 0.13 µg/m^3.

- The median concentration increases slightly each year between 2012 and 2014, decreases for 2015 (as does the 1-year average concentration), then increases again for 2016. The changes in the median concentration, however, vary by less than 0.02 µg/m^3 over the years of sampling.

12.4 Additional Risk-Based Screening Evaluations

The following risk-based screening evaluations were conducted to characterize risk related to the air toxics measured at the Kentucky monitoring sites. Refer to Sections 3.2, 3.4.2.3, and 3.4.2.4 for definitions and explanations regarding the various toxicity factors, time frames, and calculations associated with these risk-based screenings.

12.4.1 Cancer Risk and Noncancer Hazard Approximations

For the pollutants of interest for the Kentucky monitoring sites, risk was examined by calculating cancer risk and noncancer hazard approximations for each year annual average concentrations could be calculated. These approximations can be used as risk estimates for cancer and noncancer effects attributable to the pollutants of interest. Although the use of these approximations is limited, they may help identify where policy-makers want to shift their air monitoring priorities. Refer to Section 3.4.2.3 for an explanation of how cancer risk and noncancer hazard approximations are calculated and what limitations are associated with them. Annual averages, cancer UREs and/or noncancer RfCs, and cancer risk and noncancer hazard approximations are presented in Table 12-5, where applicable. Cancer risk approximations are presented as probabilities while the noncancer hazard approximations are ratios and thus, unitless values.

Table 12-5. Risk Approximations for the Kentucky Monitoring Sites

Pollutant	Cancer URE ($\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	2015				2016			
			# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Risk Approximations		# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Risk Approximations	
					Cancer (in-a-million)	Noncancer (HQ)			Cancer (in-a-million)	Noncancer (HQ)
Health Department, Ashland, Kentucky - ASKY										
Benzene	0.0000078	0.03	60/60	0.78 ± 0.11	6.08	0.03	60/60	0.65 ± 0.10	5.10	0.02
1,3-Butadiene	0.00003	0.002	56/60	0.06 ± 0.01	1.92	0.03	55/60	0.06 ± 0.01	1.94	0.03
Carbon Tetrachloride	0.000006	0.1	60/60	0.62 ± 0.03	3.71	0.01	60/60	0.64 ± 0.02	3.85	0.01
1,2-Dichloroethane	0.000026	2.4	59/60	0.08 ± 0.01	1.96	<0.01	53/60	0.07 ± 0.01	1.78	<0.01
Hexachloro-1,3-butadiene	0.000022	0.09	2/60	NR	NR	NR	15/60	0.02 ± 0.01	0.41	<0.01
21st and Greenup, Ashland, Kentucky - ASKY-M										
Arsenic (PM_{10})[a]	0.0043	0.000015	55/55	1.38 ± 0.32	5.93	0.09	55/55	1.13 ± 0.23	4.86	0.08
Cadmium (PM_{10})[a]	0.0018	0.00001	55/55	0.32 ± 0.08	0.58	0.03	55/55	0.39 ± 0.22	0.71	0.04
Lead (PM_{10})[a]	--	0.00015	55/55	8.83 ± 2.08	--	0.06	55/55	6.97 ± 1.86	--	0.05
Manganese (PM_{10})[a]	--	0.0003	55/55	25.05 ± 5.70	--	0.08	55/55	19.85 ± 4.75	--	0.07
Nickel (PM_{10})[a]	0.00048	0.00009	55/55	2.20 ± 0.49	1.06	0.02	55/55	2.12 ± 0.62	1.02	0.02

[a] Average concentrations provided below the blue line for this site and/or pollutant are presented in ng/m^3 for ease of viewing.
NA = Not available because the criteria for calculating an annual average were not met.
NR = Not reportable due to invalidation related to a contaminated internal standard.
-- = A Cancer URE or Noncancer RfC is not available.

Table 12-5. Risk Approximations for the Kentucky Monitoring Sites (Continued)

Pollutant	Cancer URE ($\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	2015				2016			
			# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Risk Approximations		# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Risk Approximations	
					Cancer (in-a-million)	Noncancer (HQ)			Cancer (in-a-million)	Noncancer (HQ)
Grayson, Kentucky - GLKY										
Acetaldehyde	0.0000022	0.009	60/60	0.87 ± 0.07	1.92	0.10	61/61	0.86 ± 0.10	1.89	0.10
Benzene	0.0000078	0.03	60/60	0.39 ± 0.04	3.05	0.01	61/61	0.39 ± 0.04	3.01	0.01
1,3-Butadiene	0.00003	0.002	51/60	0.03 ± 0.01	0.98	0.02	47/61	0.03 ± 0.01	0.93	0.02
Carbon Tetrachloride	0.000006	0.1	60/60	0.62 ± 0.02	3.74	0.01	61/61	0.63 ± 0.02	3.79	0.01
1,2-Dichloroethane	0.000026	2.4	58/60	0.06 ± 0.01	1.61	<0.01	51/61	0.06 ± 0.01	1.47	<0.01
Formaldehyde	0.000013	0.0098	60/60	1.76 ± 0.25	22.86	0.18	61/61	1.87 ± 0.24	24.35	0.19
Arsenic (PM_{10})[a]	0.0043	0.000015	57/58	0.54 ± 0.09	2.33	0.04	59/59	0.53 ± 0.11	2.27	0.04
Baskett, Kentucky - BAKY										
Arsenic (PM_{10})[a]	0.0043	0.000015	56/56	0.96 ± 0.19	4.15	0.06	58/58	0.92 ± 0.15	3.96	0.06

[a] Average concentrations provided below the blue line for this site and/or pollutant are presented in ng/m^3 for ease of viewing.
NA = Not available because the criteria for calculating an annual average were not met.
NR = Not reportable due to invalidation related to a contaminated internal standard.
-- = A Cancer URE or Noncancer RfC is not available.

Table 12-5. Risk Approximations for the Kentucky Monitoring Sites (Continued)

Pollutant	Cancer URE ($\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	2015				2016			
			# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Risk Approximations		# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Risk Approximations	
					Cancer (in-a-million)	Noncancer (HQ)			Cancer (in-a-million)	Noncancer (HQ)
Atmos Energy, Calvert City, Kentucky - ATKY										
Benzene	0.0000078	0.03	59/59	0.96 ± 0.32	7.48	0.03	61/61	0.57 ± 0.10	4.45	0.02
1,3-Butadiene	0.00003	0.002	56/59	0.06 ± 0.02	1.84	0.03	52/61	0.05 ± 0.01	1.47	0.02
Carbon Tetrachloride	0.000006	0.1	59/59	0.67 ± 0.03	4.04	0.01	61/61	0.69 ± 0.03	4.11	0.01
1,2-Dichloroethane	0.000026	2.4	59/59	0.41 ± 0.19	10.65	<0.01	60/61	0.90 ± 0.55	23.46	<0.01
Hexachloro-1,3-butadiene	0.000022	0.09	3/59	NR	NR	NR	14/61	0.02 ± 0.01	0.46	<0.01
1,1,2-Trichloroethane	0.000016	0.4	6/59	0.01 ± 0.01	0.14	<0.01	9/61	0.09 ± 0.08	1.43	<0.01
Vinyl chloride	0.0000088	0.1	45/59	0.69 ± 0.32	6.07	0.01	50/61	0.83 ± 0.54	7.33	0.01

[a] Average concentrations provided below the blue line for this site and/or pollutant are presented in ng/m^3 for ease of viewing.
NA = Not available because the criteria for calculating an annual average were not met.
NR = Not reportable due to invalidation related to a contaminated internal standard.
-- = A Cancer URE or Noncancer RfC is not available.

Table 12-5. Risk Approximations for the Kentucky Monitoring Sites (Continued)

Pollutant	Cancer URE ($\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	2015				2016			
			# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Risk Approximations		# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Risk Approximations	
					Cancer (in-a-million)	Noncancer (HQ)			Cancer (in-a-million)	Noncancer (HQ)
Smithland, Kentucky - BLKY										
Benzene	0.0000078	0.03	59/59	0.56 ± 0.06	4.39	0.02	60/60	0.49 ± 0.07	3.85	0.02
1,3-Butadiene	0.00003	0.002	51/59	0.06 ± 0.02	1.84	0.03	49/60	0.06 ± 0.03	1.87	0.03
Carbon Tetrachloride	0.000006	0.1	59/59	0.67 ± 0.03	4.02	0.01	60/60	0.73 ± 0.04	4.40	0.01
1,2-Dichloroethane	0.000026	2.4	59/59	0.72 ± 0.29	18.64	<0.01	58/60	1.89 ± 1.55	49.10	<0.01
Hexachloro-1,3-butadiene	0.000022	0.09	6/59	NR	NR	NR	17/60	0.03 ± 0.01	0.57	<0.01
Vinyl chloride	0.0000088	0.1	41/59	0.10 ± 0.04	0.92	<0.01	47/60	0.17 ± 0.07	1.48	<0.01
Arsenic (PM_{10})[a]	0.0043	0.000015	50/51	0.57 ± 0.09	2.43	0.04	59/59	0.54 ± 0.07	2.34	0.04

[a] Average concentrations provided below the blue line for this site and/or pollutant are presented in ng/m^3 for ease of viewing.

NA = Not available because the criteria for calculating an annual average were not met.

NR = Not reportable due to invalidation related to a contaminated internal standard.

-- = A Cancer URE or Noncancer RfC is not available.

Table 12-5. Risk Approximations for the Kentucky Monitoring Sites (Continued)

Pollutant	Cancer URE ($\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	2015 # of Measured Detections vs. # of Samples	2015 Annual Average ($\mu g/m^3$)	2015 Risk Approximations Cancer (in-a-million)	2015 Risk Approximations Noncancer (HQ)	2016 # of Measured Detections vs. # of Samples	2016 Annual Average ($\mu g/m^3$)	2016 Risk Approximations Cancer (in-a-million)	2016 Risk Approximations Noncancer (HQ)
TVA Substation, Calvert City, Kentucky - TVKY										
Benzene	0.0000078	0.03	62/62	1.04 ± 0.30	8.10	0.03	61/61	0.54 ± 0.09	4.21	0.02
1,3-Butadiene	0.00003	0.002	56/62	0.35 ± 0.19	10.55	0.18	52/61	0.16 ± 0.12	4.75	0.08
Carbon Tetrachloride	0.000006	0.1	62/62	0.85 ± 0.13	5.10	0.01	61/61	0.80 ± 0.10	4.78	0.01
1,2-Dichloroethane	0.000026	2.4	62/62	3.75 ± 1.56	97.62	<0.01	60/61	3.49 ± 1.36	90.70	<0.01
1,1,2-Trichloroethane	0.000016	0.4	13/62	0.03 ± 0.02	0.47	<0.01	16/61	0.09 ± 0.08	1.52	<0.01
Vinyl chloride	0.0000088	0.1	42/62	0.30 ± 0.12	2.60	<0.01	53/61	0.31 ± 0.11	2.77	<0.01
Lexington, Kentucky - LEKY										
Benzene	0.0000078	0.03	53/53	0.51 ± 0.06	3.96	0.02	29/29	NA	NA	NA
1,3-Butadiene	0.00003	0.002	47/53	0.06 ± 0.01	1.71	0.03	28/29	NA	NA	NA
Carbon Tetrachloride	0.000006	0.1	53/53	0.63 ± 0.02	3.77	0.01	29/29	NA	NA	NA
p-Dichlorobenzene	0.000011	0.8	26/53	0.03 ± 0.01	0.36	<0.01	9/29	NA	NA	NA
1,2-Dichloroethane	0.000026	2.4	51/53	0.07 ± 0.01	1.73	<0.01	29/29	NA	NA	NA
Arsenic (PM_{10})[a]	0.0043	0.000015	56/56	0.81 ± 0.17	3.50	0.05	47/47	NA	NA	NA

[a] Average concentrations provided below the blue line for this site and/or pollutant are presented in ng/m^3 for ease of viewing.
NA = Not available because the criteria for calculating an annual average were not met.
NR = Not reportable due to invalidation related to a contaminated internal standard.
-- = A Cancer URE or Noncancer RfC is not available.

Observations for the Kentucky monitoring sites from Table 12-5 include the following:

- The pollutants with the highest annual average concentrations for both years for ASKY are benzene and carbon tetrachloride. These two pollutants also have the highest cancer risk approximations for ASKY. All of the noncancer hazard approximations for the pollutants of interest for ASKY are considerably less than an HQ of 1.0 (0.03 or less), indicating that no adverse noncancer health effects are expected from these individual pollutants.

- The pollutant of interest with the highest annual average concentrations for ASKY-M is manganese. Arsenic has the highest cancer risk approximations among ASKY-M's pollutants of interest. (Note that lead and manganese do not have cancer UREs.) All of the noncancer hazard approximations for the pollutants of interest for ASKY-M are considerably less than an HQ of 1.0 (0.09 or less), indicating that no adverse noncancer health effects are expected from these individual pollutants.

- Formaldehyde is the only pollutant of interest for GLKY with annual average concentrations greater than 1 $\mu g/m^3$. This pollutant also has the highest cancer risk approximations for GLKY. All of the noncancer hazard approximations for the pollutants of interest for GLKY are considerably less than an HQ of 1.0 (0.19 or less), indicating that no adverse noncancer health effects are expected from these individual pollutants.

- Arsenic is the only pollutant of interest for BAKY. BAKY's cancer risk approximation for arsenic for 2015 is just greater than 4 in-a-million while the cancer risk approximation for 2016 is just less than 4 in-a-million. The noncancer hazard approximations for arsenic for BAKY are considerably less than an HQ of 1.0 (both are 0.06), indicating that no adverse noncancer health effects are expected from this individual pollutant.

- 1,2-Dichloroethane has the highest cancer risk approximations among the pollutants of interest for the Calvert City sites, each one greater than 10 in-a-million and ranging from 10.65 in-a-million (ATKY, 2015) to 97.62 in-a-million (TVKY, 2015). Both of TVKY's cancer risk approximations are greater than 90 in-a-million. These cancer risk approximations for TVKY are the highest ones calculated in the 2015-2016 NMP report. TVKY's cancer risk approximation for 1,3-butadiene for 2015 is also greater than 10 in-a-million, which is the highest approximation calculated for this pollutant across the program.

- All of the noncancer hazard approximations for the pollutants of interest for the Calvert City sites are considerably less than an HQ of 1.0 (0.18 or less), indicating that no adverse noncancer health effects are expected from these individual pollutants.

- Carbon tetrachloride and benzene are the pollutants of interest for LEKY with the highest annual average concentrations (2015 only). These pollutants also have the highest cancer risk approximations for LEKY, both of which are just less than 4-in-a-million. All of the noncancer hazard approximations for the pollutants of interest for LEKY are considerably less than an HQ of 1.0 (0.05 or less), indicating

that no adverse noncancer health effects are expected from these individual pollutants.

As an extension of this analysis, pollution roses were created for each of the site-specific pollutants of interest that have a cancer risk approximation greater than 75 in-a-million and/or a noncancer hazard approximation greater than 1.0, where applicable. Thus, a pollution rose was created for TVKY's 1,2-dichloroethane measurements. A pollution rose is a plot of the ambient concentration versus the wind direction; the magnitude of the concentration is indicated using different colored dots and are shown in relation to the average wind direction oriented about a 16-point compass. Thus, high concentrations may be shown in relation to the direction of potential emissions sources. Hourly wind observations collected at the NWS station at the Barkley Regional Airport and obtained from NOAA are used in this analysis and were averaged (using vector averaging techniques) to compute daily wind direction averages for comparison to the 24-hour concentration data. This analysis is intended to help identify the geographical area where the emissions sources of these pollutants may have originated. Additional information regarding this analysis is also presented in Section 3.4.2.3. Figure 12-72 presents the pollution rose for all 122 1,2-dichloroethane concentrations measured at TVKY over the two-year sampling period.

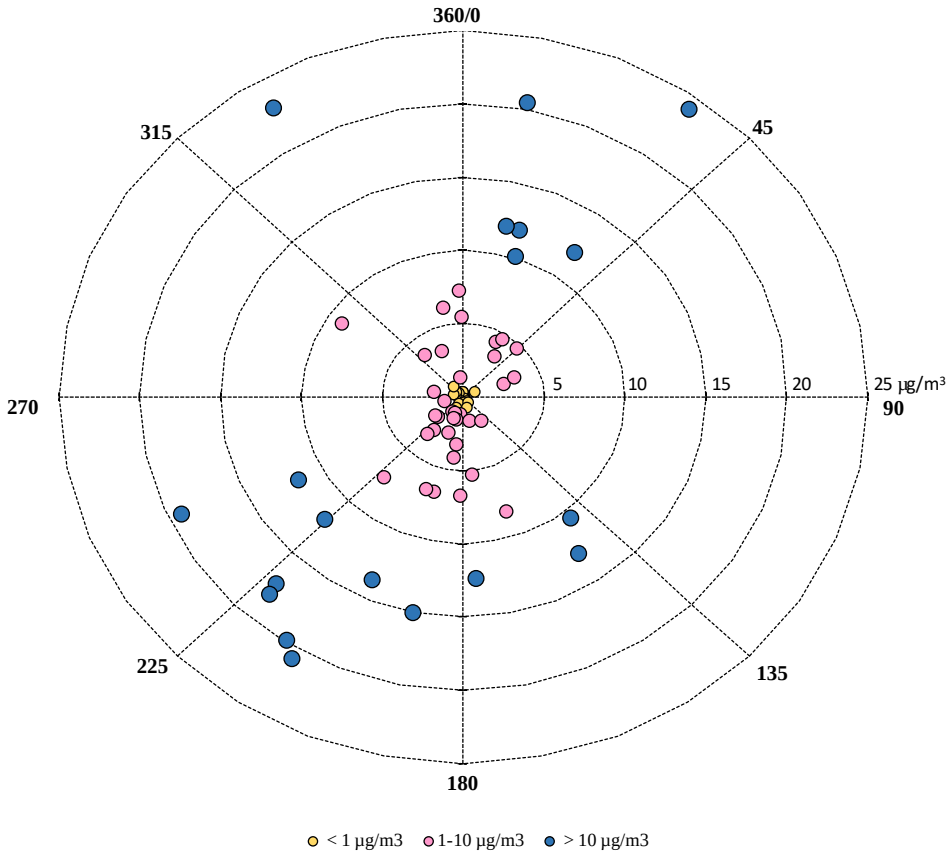
Observations for Figure 12-72 include the following:

- Concentrations greater than 10 $\mu g/m^3$ are plotted on the pollution rose in blue, with pink representing concentrations between 1 $\mu g/m^3$ and 10 $\mu g/m^3$ and yellow representing concentrations less than 1 $\mu g/m^3$.

- The pollution rose shows that the concentrations greater than 10 $\mu g/m^3$ tended to be measured at TVKY primarily on days with an average wind direction between 0° (north) and 45° (northeast) or between 135° (southeast) and 225° (southwest), with a few exceptions. Concentrations between 1 $\mu g/m^3$ and 10 $\mu g/m^3$ were most often measured on sample days with an average wind direction between 315° (northwest) and 45° (northeast) or between 135° (southeast) and 225° (southwest), although there are exceptions to this as well. Few 1,2-dichloroethane concentrations greater than 1 $\mu g/m^3$ were measured on days with an average wind direction from the east or west.

- This pollution rose shows that 1,2-dichloroethane concentrations less than 1 $\mu g/m^3$ were measured at TVKY on sample days with a variety of average wind directions. However, these lower concentrations were infrequently measured on days with an average wind direction between 45° (northeast) and 135° (southeast).

Figure 12-72. Pollution Roses for 1,2-Dichloroethane Concentrations Measured at TVKY



12.4.2 Risk-Based Emissions Assessment

In addition to the risk-based screening discussed above, Tables 12-6 and 12-7 present an evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 12-6 presents the 10 pollutants with the highest emissions from the 2014 NEI (version 1) that have cancer toxicity factors. Table 12-6 also presents the 10 pollutants with the highest toxicity-weighted emissions, based on the weighting schema described in Section 3.4.2.4. Lastly, Table 12-6 provides the pollutants with the highest cancer risk approximations (in-a-million) for each site, as presented in Table 12-5. Cancer risk approximations for 2015 are presented in green while approximations for 2016 are in white. The emissions, toxicity-weighted emissions, and cancer risk approximations are shown in descending order in Table 12-6. Table 12-7 presents similar information, but is limited to those pollutants with noncancer toxicity factors.

Because not all pollutants have both cancer and noncancer toxicity factors, the highest emitted pollutants in the cancer table may be different from the noncancer table, although the actual quantity of emissions is the same. The cancer risk and noncancer hazard approximations based on each site's annual averages are limited to the pollutants of interest identified for each site. In addition, the cancer risk and noncancer hazard approximations are limited to those pollutants with enough data to meet the criteria for annual averages to be calculated. A more in-depth discussion of this analysis is provided in Section 3.4.2.4. Similar to the cancer risk and noncancer hazard approximations provided in Section 12.4.1, this analysis may help policy-makers prioritize their air monitoring activities.

Table 12-6. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Kentucky Monitoring Sites

Top 10 Total Emissions for Pollutants with Cancer UREs (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Health Department, Ashland, Kentucky (Boyd County) - ASKY					
Benzene	29.01	Nickel, PM	8.18E-04	Benzene	6.08
Formaldehyde	16.75	Hexavalent Chromium, PM	7.61E-04	Benzene	5.10
Acetaldehyde	10.14	2,4-Dinitrotoluene	3.91E-04	Carbon Tetrachloride	3.85
Ethylbenzene	9.11	Benzene	2.26E-04	Carbon Tetrachloride	3.71
2,4-Dinitrotoluene	4.39	Formaldehyde	2.18E-04	1,2-Dichloroethane	1.96
Naphthalene	2.52	Naphthalene	8.58E-05	1,3-Butadiene	1.94
1,3-Butadiene	2.32	Nitrobenzene	7.27E-05	1,3-Butadiene	1.92
Bis(2-ethylhexyl) phthalate, gas	2.27	1,3-Butadiene	6.97E-05	1,2-Dichloroethane	1.78
Nitrobenzene	1.82	Cadmium, PM	4.78E-05	Hexachloro-1,3-butadiene	0.41
Nickel, PM	1.70	POM, Group 2b	3.14E-05		
21st and Greenup, Ashland, Kentucky (Boyd County) - ASKY-M					
Benzene	29.01	Nickel, PM	8.18E-04	Arsenic	5.93
Formaldehyde	16.75	Hexavalent Chromium, PM	7.61E-04	Arsenic	4.86
Acetaldehyde	10.14	2,4-Dinitrotoluene	3.91E-04	Nickel	1.06
Ethylbenzene	9.11	Benzene	2.26E-04	Nickel	1.02
2,4-Dinitrotoluene	4.39	Formaldehyde	2.18E-04	Cadmium	0.71
Naphthalene	2.52	Naphthalene	8.58E-05	Cadmium	0.58
1,3-Butadiene	2.32	Nitrobenzene	7.27E-05		
Bis(2-ethylhexyl) phthalate, gas	2.27	1,3-Butadiene	6.97E-05		
Nitrobenzene	1.82	Cadmium, PM	4.78E-05		
Nickel, PM	1.70	POM, Group 2b	3.14E-05		

[1] Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Table 12-6. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Kentucky Monitoring Sites (Continued)

Top 10 Total Emissions for Pollutants with Cancer UREs (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Grayson, Kentucky (Carter County) - GLKY					
Benzene	14.81	Formaldehyde	1.78E-04	Formaldehyde	24.35
Formaldehyde	13.70	Benzene	1.16E-04	Formaldehyde	22.86
Acetaldehyde	8.80	Naphthalene	7.26E-05	Carbon Tetrachloride	3.79
Ethylbenzene	5.87	1,3-Butadiene	5.24E-05	Carbon Tetrachloride	3.74
Naphthalene	2.14	POM, Group 2b	3.25E-05	Benzene	3.05
1,3-Butadiene	1.75	POM, Group 2d	2.54E-05	Benzene	3.01
Bis(2-ethylhexyl) phthalate, gas	1.27	POM, Group 5a	2.36E-05	Arsenic	2.33
POM, Group 2b	0.37	Acetaldehyde	1.94E-05	Arsenic	2.27
POM, Group 2d	0.29	Ethylbenzene	1.47E-05	Acetaldehyde	1.92
2,4-Toluene diisocyanate	0.11	POM, Group 6	6.72E-06	Acetaldehyde	1.89
Baskett, Kentucky (Henderson County) - BAKY					
Benzene	28.00	Naphthalene	6.53E-04	Arsenic	4.15
Formaldehyde	27.39	Formaldehyde	3.56E-04	Arsenic	3.96
Naphthalene	19.21	Nickel, PM	3.12E-04		
Acetaldehyde	15.32	Benzene	2.18E-04		
Ethylbenzene	15.19	1,3-Butadiene	1.01E-04		
Tetrachloroethylene	4.71	POM, Group 2b	4.55E-05		
1,3-Butadiene	3.36	Cadmium, PM	4.47E-05		
Bis(2-ethylhexyl) phthalate, gas	2.15	Ethylbenzene	3.80E-05		
Dichloromethane	0.85	POM, Group 2d	3.62E-05		
Nickel, PM	0.65	Acetaldehyde	3.37E-05		

[1] Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Table 12-6. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Kentucky Monitoring Sites (Continued)

Top 10 Total Emissions for Pollutants with Cancer UREs (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Atmos Energy, Calvert City, Kentucky (Marshall County) - ATKY					
Benzene	62.95	Benzene	4.91E-04	1,2-Dichloroethane	23.46
Ethylbenzene	37.64	Formaldehyde	4.06E-04	1,2-Dichloroethane	10.65
Formaldehyde	31.25	Arsenic, PM	3.16E-04	Benzene	7.48
Acetaldehyde	27.52	Vinyl chloride	2.41E-04	Vinyl chloride	7.33
Vinyl chloride	27.36	1,2-Dichloroethane	2.34E-04	Vinyl chloride	6.07
1,2-Dichloroethane	9.01	1,3-Butadiene	2.34E-04	Benzene	4.45
1,3-Butadiene	7.80	Hexachlorobenzene	2.18E-04	Carbon Tetrachloride	4.11
Naphthalene	5.94	Naphthalene	2.02E-04	Carbon Tetrachloride	4.04
Bis(2-ethylhexyl) phthalate, gas	1.45	Hexavalent Chromium, PM	9.68E-05	1,3-Butadiene	1.84
Carbon tetrachloride	1.43	Ethylbenzene	9.41E-05	1,3-Butadiene	1.47
TVA Substation, Calvert City, Kentucky (Marshall County) - TVKY					
Benzene	62.95	Benzene	4.91E-04	1,2-Dichloroethane	97.62
Ethylbenzene	37.64	Formaldehyde	4.06E-04	1,2-Dichloroethane	90.70
Formaldehyde	31.25	Arsenic, PM	3.16E-04	1,3-Butadiene	10.55
Acetaldehyde	27.52	Vinyl chloride	2.41E-04	Benzene	8.10
Vinyl chloride	27.36	1,2-Dichloroethane	2.34E-04	Carbon Tetrachloride	5.10
1,2-Dichloroethane	9.01	1,3-Butadiene	2.34E-04	Carbon Tetrachloride	4.78
1,3-Butadiene	7.80	Hexachlorobenzene	2.18E-04	1,3-Butadiene	4.75
Naphthalene	5.94	Naphthalene	2.02E-04	Benzene	4.21
Bis(2-ethylhexyl) phthalate, gas	1.45	Hexavalent Chromium, PM	9.68E-05	Vinyl chloride	2.77
Carbon tetrachloride	1.43	Ethylbenzene	9.41E-05	Vinyl chloride	2.60

[1] Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Table 12-6. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Kentucky Monitoring Sites (Continued)

Top 10 Total Emissions for Pollutants with Cancer UREs (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Smithland, Kentucky (Livingston County) - BLKY					
Benzene	11.51	Formaldehyde	1.19E-04	1,2-Dichloroethane	49.10
Formaldehyde	9.13	Benzene	8.98E-05	1,2-Dichloroethane	18.64
Ethylbenzene	7.04	1,3-Butadiene	4.81E-05	Carbon Tetrachloride	4.40
Acetaldehyde	5.22	Naphthalene	4.07E-05	Benzene	4.39
1,3-Butadiene	1.60	POM, Group 2b	2.09E-05	Carbon Tetrachloride	4.02
Naphthalene	1.20	Ethylbenzene	1.76E-05	Benzene	3.85
Bis(2-ethylhexyl) phthalate, gas	0.44	POM, Group 2d	1.65E-05	Arsenic	2.43
POM, Group 2b	0.24	POM, Group 5a	1.36E-05	Arsenic	2.34
POM, Group 2d	0.19	Acetaldehyde	1.15E-05	1,3-Butadiene	1.87
2,4-Toluene diisocyanate	0.04	Nickel, PM	9.57E-06	1,3-Butadiene	1.84
Lexington, Kentucky (Fayette County) - LEKY					
Benzene	106.03	Formaldehyde	1.15E-03	Benzene	3.96
Formaldehyde	88.65	Benzene	8.27E-04	Carbon Tetrachloride	3.77
Ethylbenzene	69.29	Naphthalene	5.92E-04	Arsenic	3.50
Acetaldehyde	58.48	1,3-Butadiene	4.63E-04	1,2-Dichloroethane	1.73
Naphthalene	17.42	Ethylene oxide	2.98E-04	1,3-Butadiene	1.71
1,3-Butadiene	15.43	POM, Group 2b	1.82E-04	*p*-Dichlorobenzene	0.36
Bis(2-ethylhexyl) phthalate, gas	14.33	Ethylbenzene	1.73E-04		
POM, Group 2b	2.07	POM, Group 2d	1.47E-04		
POM, Group 2d	1.67	Acetaldehyde	1.29E-04		
2,4-Toluene diisocyanate	1.23	POM, Group 5a	1.17E-04		

[1] Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Table 12-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the Kentucky Monitoring Sites

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Hazard Approximation (HQ)**
Health Department, Ashland, Kentucky (Boyd County) - ASKY					
Toluene	79.35	Acrolein	56,574.58	1,3-Butadiene	0.03
Methanol	34.79	Chlorine	24,334.81	1,3-Butadiene	0.03
Xylenes	33.38	Manganese, PM	21,583.40	Benzene	0.03
Benzene	29.01	Nickel, PM	18,936.65	Benzene	0.02
Hexane	17.21	Lead, PM	4,636.36	Carbon Tetrachloride	0.01
Formaldehyde	16.75	2,4-Toluene diisocyanate	2,782.50	Carbon Tetrachloride	0.01
Hydrochloric acid	12.92	Cyanide Compounds, gas	2,677.09	Hexachloro-1,3-butadiene	<0.01
Acetaldehyde	10.14	Cadmium, PM	2,652.82	1,2-Dichloroethane	<0.01
Ethylbenzene	9.11	Formaldehyde	1,709.26	1,2-Dichloroethane	<0.01
Manganese, PM	6.48	1,3-Butadiene	1,161.65		
21st and Greenup, Ashland, Kentucky (Boyd County) - ASKY-M					
Toluene	79.35	Acrolein	56,574.58	Arsenic	0.09
Methanol	34.79	Chlorine	24,334.81	Manganese	0.08
Xylenes	33.38	Manganese, PM	21,583.40	Arsenic	0.08
Benzene	29.01	Nickel, PM	18,936.65	Manganese	0.07
Hexane	17.21	Lead, PM	4,636.36	Lead	0.06
Formaldehyde	16.75	2,4-Toluene diisocyanate	2,782.50	Lead	0.05
Hydrochloric acid	12.92	Cyanide Compounds, gas	2,677.09	Cadmium	0.04
Acetaldehyde	10.14	Cadmium, PM	2,652.82	Cadmium	0.03
Ethylbenzene	9.11	Formaldehyde	1,709.26	Nickel	0.02
Manganese, PM	6.48	1,3-Butadiene	1,161.65	Nickel	0.02

[1] Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Table 12-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the Kentucky Monitoring Sites (Continued)

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Hazard Approximation (HQ)**
Grayson, Kentucky (Carter County) - GLKY					
Toluene	37.11	Acrolein	44,756.45	Formaldehyde	0.19
Xylenes	21.60	2,4-Toluene diisocyanate	1,550.91	Formaldehyde	0.18
Benzene	14.81	Formaldehyde	1,397.83	Acetaldehyde	0.10
Formaldehyde	13.70	Cyanide Compounds, gas	1,234.28	Acetaldehyde	0.10
Methanol	11.57	Acetaldehyde	978.25	Arsenic	0.04
Acetaldehyde	8.80	1,3-Butadiene	873.28	Arsenic	0.04
Hexane	8.17	Naphthalene	712.11	1,3-Butadiene	0.02
Ethylbenzene	5.87	Benzene	493.75	1,3-Butadiene	0.02
Naphthalene	2.14	Xylenes	216.03	Benzene	0.01
Styrene	2.04	Bis(2-ethylhexyl) phthalate, gas	126.76	Benzene	0.01
Baskett, Kentucky (Henderson County) - BAKY					
Carbonyl sulfide	269.44	Acrolein	110,810.57	Arsenic	0.06
Hydrofluoric acid	131.41	Hydrofluoric acid	9,386.18	Arsenic	0.06
Toluene	82.09	Manganese, PM	8,045.76		
Xylenes	54.05	Nickel, PM	7,213.21		
Benzene	28.00	Naphthalene	6,403.35		
Formaldehyde	27.39	Chlorine	3,106.53		
Methanol	23.45	4,4-Methylenediphenyl diisocyanate, gas	3,053.82		
Hexane	19.36	Formaldehyde	2,794.74		
Naphthalene	19.21	2,4-Toluene diisocyanate	2,636.22		
Acetaldehyde	15.32	Cadmium, PM	2,481.69		

[1] Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Table 12-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the Kentucky Monitoring Sites (Continued)

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Hazard Approximation (HQ)**
Atmos Energy, Calvert City, Kentucky (Marshall County) - ATKY					
Methanol	548.56	Chlorine	921,670.25	Benzene	0.03
Toluene	155.41	Acrolein	91,798.74	1,3-Butadiene	0.03
Xylenes	140.83	Hydrochloric acid	6,166.28	1,3-Butadiene	0.02
Chlorine	138.25	Arsenic, PM	4,904.75	Benzene	0.02
Hydrochloric acid	123.33	1,3-Butadiene	3,898.17	Vinyl chloride	0.01
Benzene	62.95	Formaldehyde	3,188.52	Vinyl chloride	0.01
Vinyl acetate	57.82	Acetaldehyde	3,057.90	Carbon Tetrachloride	0.01
Ethylbenzene	37.64	Manganese, PM	2,784.81	Carbon Tetrachloride	0.01
Formaldehyde	31.25	Acrylic acid	2,725.48	1,2-Dichloroethane	<0.01
Hexane	27.94	Benzene	2,098.49	Hexachloro-1,3-butadiene	<0.01
TVA Substation, Calvert City, Kentucky (Marshall County) - TVKY					
Methanol	548.56	Chlorine	921,670.25	1,3-Butadiene	0.18
Toluene	155.41	Acrolein	91,798.74	1,3-Butadiene	0.08
Xylenes	140.83	Hydrochloric acid	6,166.28	Benzene	0.03
Chlorine	138.25	Arsenic, PM	4,904.75	Benzene	0.02
Hydrochloric acid	123.33	1,3-Butadiene	3,898.17	Carbon Tetrachloride	0.01
Benzene	62.95	Formaldehyde	3,188.52	Carbon Tetrachloride	0.01
Vinyl acetate	57.82	Acetaldehyde	3,057.90	Vinyl chloride	<0.01
Ethylbenzene	37.64	Manganese, PM	2,784.81	Vinyl chloride	<0.01
Formaldehyde	31.25	Acrylic acid	2,725.48	1,2-Dichloroethane	<0.01
Hexane	27.94	Benzene	2,098.49	1,2-Dichloroethane	<0.01

[1] Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Table 12-7. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the Kentucky Monitoring Sites (Continued)

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Hazard Approximation (HQ)**
Smithland, Kentucky (Livingston County) - BLKY					
Toluene	37.15	Acrolein	31,963.47	Arsenic	0.04
Xylenes	24.92	Formaldehyde	931.75	Arsenic	0.04
Benzene	11.51	1,3-Butadiene	802.24	1,3-Butadiene	0.03
Formaldehyde	9.13	Acetaldehyde	579.95	1,3-Butadiene	0.03
Hexane	7.82	2,4-Toluene diisocyanate	532.37	Benzene	0.02
Ethylbenzene	7.04	Cyanide Compounds, gas	509.85	Benzene	0.02
Acetaldehyde	5.22	Naphthalene	399.44	Carbon Tetrachloride	0.01
Methanol	3.91	Benzene	383.60	Carbon Tetrachloride	0.01
1,3-Butadiene	1.60	Manganese, PM	303.10	Vinyl chloride	<0.01
Styrene	1.35	Xylenes	249.19	Vinyl chloride	<0.01
Lexington, Kentucky (Fayette County) - LEKY					
Toluene	434.79	Acrolein	305,893.45	Arsenic	0.05
Xylenes	248.80	2,4-Toluene diisocyanate	17,526.57	1,3-Butadiene	0.03
Methanol	152.86	Formaldehyde	9,045.61	Benzene	0.02
Benzene	106.03	1,3-Butadiene	7,715.19	Carbon Tetrachloride	0.01
Formaldehyde	88.65	Acetaldehyde	6,497.82	*p*-Dichlorobenzene	<0.01
Hexane	82.79	Manganese, PM	5,988.12	1,2-Dichloroethane	<0.01
Ethylbenzene	69.29	Naphthalene	5,806.27		
Acetaldehyde	58.48	Benzene	3,534.28		
Ethylene glycol	19.99	Hexamethylene-1,6-diisocyanate, gas	3,371.90		
Naphthalene	17.42	Xylenes	2,488.00		

[1] Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Observations from Table 12-6 include the following:

- Among the Kentucky counties with NMP monitoring sites, emissions (for pollutants with cancer UREs) are highest in Fayette County (LEKY) and Marshall County (ATKY, TVKY) and lowest in Livingston County (BLKY) and Carter County (GLKY).

- Benzene, formaldehyde, acetaldehyde are the highest emitted pollutants with cancer UREs in Boyd County, where the Ashland sites are located. Nickel, hexavalent chromium, and 2,4-dinitrotoluene are the pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) for Boyd County. Seven of the highest emitted pollutants also have the highest toxicity-weighted emissions for Boyd County.

- Benzene has the highest cancer risk approximations for ASKY and appears on both emissions-based lists (ranking highest for quantity emitted and fourth for its toxicity-weighted emissions). 1,3-Butadiene also appears on all three lists (ranking seventh highest for quantity emitted and eighth for its toxicity-weighted emissions). Carbon tetrachloride, 1,2-dichloroethane, and hexachloro-1,3-butadiene are also pollutants of interest for ASKY but appear on neither emissions-based list for Boyd County.

- Nickel is the only pollutant of interest for ASKY-M to appear on both emissions-based lists for Boyd County (ranking tenth highest for quantity emitted and highest for its toxicity-weighted emissions). While cadmium ranks ninth in Boyd County for its toxicity-weighted emissions, it is not among the highest emitted (ranking 19th). Arsenic, which has the highest cancer risk approximations for ASKY-M, appears on neither emissions-based list (ranking 24th for total emissions and 15th for toxicity-weighted emissions).

- Benzene, formaldehyde, and acetaldehyde are the highest emitted pollutants with cancer UREs in Carter County, where GLKY is located. Formaldehyde, benzene, and naphthalene are the pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) for this county. Eight of the highest emitted pollutants also have the highest toxicity-weighted emissions for Carter County.

- Formaldehyde has the highest cancer risk approximations for GLKY, ranks first for its toxicity-weighted emissions, and ranks second for its total emissions in Carter County, as shown in Table 12-6. Benzene and acetaldehyde also appear on all three lists. Carbon tetrachloride and arsenic appear on neither emissions-based list for Carter County.

- Two POM Groups appear among the highest emitted pollutants in Carter County (POM, Groups 2b and 2d) and four POM Groups appear among the pollutants with the highest toxicity-weighted emissions (POM, Groups 2b, 2d, 5a, and 6). Many of the PAHs sampled using Method TO-13A are part of POM, Groups 2b, 5a, and 6. However, none of these pollutants failed screens for GLKY. Naphthalene is also sampled for with Method TO-13A; this pollutant appears on both emissions-based lists for Carter County. Naphthalene failed screens for GLKY but was not identified as a pollutant of interest for this site.

- Benzene, formaldehyde, and naphthalene are the highest emitted pollutants with cancer UREs in Henderson County, where BAKY is located. Naphthalene, formaldehyde, and nickel are the pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) for this county. Seven of the highest emitted pollutants also have the highest toxicity-weighted emissions for Henderson County.

- Arsenic is the only pollutant of interest for BAKY. Arsenic appears on neither emissions-based list for Henderson County (arsenic ranks 24th for total emissions and 13th for toxicity-weighted emissions).

- Benzene, ethylbenzene, and formaldehyde are the highest emitted pollutants with cancer UREs in Marshall County, where two of the three Calvert City sites are located. Benzene, formaldehyde, and arsenic are the pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) for this county. Seven of the highest emitted pollutants also have the highest toxicity-weighted emissions for Marshall County.

- Marshall County is the only county with an NMP site for which vinyl chloride appears among the highest emitted pollutants. The quantity of vinyl chloride emitted in Marshall County (27.36 tpy) is the highest emissions for this pollutant among NMP counties and is considerably higher than the next highest emissions of this pollutant (9.62 tpy in Los Angeles County, California). Marshall County is also the only county with an NMP site for which carbon tetrachloride appears among the highest emitted pollutants. Marshall County is the only county with an NMP site that has carbon tetrachloride emissions greater than 1 tpy (1.43 tpy). Marshall County is also the only county with an NMP site for which 1,2-dichloroethane appears among the highest emitted pollutants. The quantity of 1,2-dichloroethane emitted in Marshall County (9.01 tpy) again ranks highest, with Monroe County, New York the next closest (4.02 tpy).

- Marshall County is the only county with an NMP site for which vinyl chloride and 1,2-dichloroethane appear among the pollutants with the highest toxicity-weighted emissions.

- Most of the VOC pollutants of interest for the Calvert City sites in Marshall County appear on both emissions-based lists. Carbon tetrachloride is the exception, as this pollutant appears among the highest emitted but not among those with the highest toxicity-weighted emissions (ranking 18th).

- Benzene, formaldehyde, and ethylbenzene are the highest emitted pollutants with cancer UREs in Livingston County, where BLKY is located. Formaldehyde, benzene, and 1,3-butadiene are the pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) for this county. Eight of the highest emitted pollutants also have the highest toxicity-weighted emissions for Livingston County.

- Benzene and 1,3-butadiene are the only two pollutants of interest for BLKY that appear among the pollutants on the emissions-based lists for Livingston County.

- Benzene, formaldehyde, and ethylbenzene are the highest emitted pollutants with cancer UREs in Fayette County, where LEKY is located. Formaldehyde, benzene, and naphthalene are the pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) for this county. Eight of the highest emitted pollutants also have the highest toxicity-weighted emissions for Fayette County.

- Benzene has the highest cancer risk approximation among LEKY's pollutants of interest. Benzene and 1,3-butadiene are the only pollutants of interest for LEKY to appear among the highest emitted pollutants in Fayette County and appear among those with the highest toxicity-weighted emissions.

Observations from Table 12-7 include the following:

- Among the Kentucky counties with monitoring sites, emissions (for pollutants with noncancer RfCs) are highest in Marshall County (ATKY, BLKY) and Fayette County (LEKY) and lowest in Carter County (GLKY) and Livingston County (BLKY).

- Toluene, methanol, and xylenes are the highest emitted pollutants with noncancer RfCs in Boyd County. Acrolein, chlorine, and manganese are the pollutants with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) for Boyd County. Two of the highest emitted pollutants also have the highest toxicity-weighted emissions for Boyd County.

- Although acrolein was sampled for at ASKY, this pollutant was excluded from the pollutants of interest designation, and thus, subsequent risk-based screening evaluations, due to questions about the consistency and reliability of the measurements, as discussed in Section 3.2. Acrolein does not appear among Boyd County's highest emitted pollutants.

- Of the pollutants of interest for ASKY, none appear on both emissions-based lists. Benzene is among the highest emitted in Boyd County but is not among those with the highest toxicity-weighted emissions. 1,3-Butadiene is among those with the highest toxicity-weighted emissions but is not among the highest emitted. The remaining pollutants of interest for ASKY appear on neither emissions-based list in Table 12-7.

- Manganese ranks tenth for its total emissions and has the third highest toxicity-weighted emissions for Boyd County. Nickel, lead, and cadmium also appear among those pollutants with the highest toxicity-weighted emissions in Boyd County, although they do not appear among the highest emitted in Boyd County. Boyd County is the only county with an NMP sites for which all four of these metals are among those with the highest toxicity-weighted emissions. Arsenic is the only pollutant of interest for ASKY-M that does not appear in either emissions-based list.

- Toluene, xylenes, and benzene are the highest emitted pollutants with noncancer RfCs in Carter County. Acrolein, 2,4-toluene diisocyanate, and formaldehyde are the pollutants with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) for Carter County. Five of the highest emitted pollutants also have the highest toxicity-weighted emissions for Carter County.

- Although acrolein was sampled for at GLKY, this pollutant was excluded from the pollutants of interest designation, and thus, subsequent risk-based screening evaluations, due to questions about the consistency and reliability of the measurements, as discussed in Section 3.2. Acrolein does not appear among Carter County's highest emitted pollutants.

- Formaldehyde, acetaldehyde, and benzene appear on all three lists for GLKY. 1,3-Butadiene is among the pollutants with the highest toxicity-weighted emissions but is not among the highest emitted in Carter County (though its emissions rank 11th). Arsenic, the only other pollutants of interest shown in Table 12-7 for GLKY, appears on neither emissions-based list for Carter County (ranking 37th for total emissions and 12th for its toxicity-weighted emissions).

- Carbonyl sulfide, hydrofluoric acid, and toluene are the highest emitted pollutants with noncancer RfCs in Henderson County. Henderson County is the only county with an NMP site for which carbonyl sulfide appears among the 10 highest emitted pollutants. Acrolein, hydrofluoric acid, and manganese are the pollutants with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) for this county. Three of the highest emitted pollutants also have the highest toxicity-weighted emissions for Henderson County.

- Arsenic is the only pollutant of interest for BAKY. Arsenic appears on neither emissions-based list (ranking 44th for total emissions and 20th for toxicity-weighted emissions). Several other metals, including manganese, nickel, and cadmium, which were sampled for at BAKY but were not identified as pollutants of interest, appear among those with the highest toxicity-weighted emissions for Henderson County (of those with noncancer RfCs).

- Methanol, toluene, and xylenes are the highest emitted pollutants with noncancer RfCs in Marshall County. Chlorine, acrolein, and hydrochloric acid are the pollutants with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) for this county. Marshall County is one of two counties with an NMP site for which acrolein was not the pollutant with the highest toxicity-weighted emissions (though it ranks second for both). Four of the highest emitted pollutants also have the highest toxicity-weighted emissions for Marshall County.

- Benzene is the only pollutant of interest for ATKY and TVKY to appear on all three lists. 1,3-Butadiene is among the pollutants with the highest noncancer hazard approximations for the sites located in Marshall County and has the fifth highest toxicity-weighted emissions but is not among the highest emitted (ranking 15th). None of the other VOC pollutants of interest for ATKY or TVKY appear on either emissions-based list for Marshall County.

- Toluene, xylenes, and benzene are the highest emitted pollutants with noncancer RfCs in Livingston County. Acrolein, formaldehyde, and 1,3-butadiene are the pollutants with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) for this county. Five of the highest emitted pollutants also have the highest toxicity-weighted emissions for Livingston County.

- Although acrolein was sampled for at BLKY, this pollutant was excluded from the pollutants of interest designation, and thus, subsequent risk-based screening evaluations, due to questions about the consistency and reliability of the measurements, as discussed in Section 3.2. Acrolein does not appear among Livingston County's highest emitted pollutants.

- Arsenic has the highest noncancer hazard approximations for BLKY but does not appear on either emissions-based list (ranking 32nd for total emissions and 12th for toxicity-weighted emissions). 1,3-Butadiene and benzene are also among BLKY's pollutants of interest with the highest noncancer hazard approximations. These two pollutants appear on both emissions-based lists for Livingston County.

- Toluene, xylenes, and methanol are the highest emitted pollutants with noncancer RfCs in Fayette County. Acrolein, 2,4-toluene diisocyanate, and formaldehyde are the pollutants with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) for this county. Five of the highest emitted pollutants also have the highest toxicity-weighted emissions for Fayette County.

- Although acrolein was sampled for at LEKY, this pollutant was excluded from the pollutants of interest designation, and thus, subsequent risk-based screening evaluations, due to questions about the consistency and reliability of the measurements, as discussed in Section 3.2. Acrolein does not appear among Fayette County's highest emitted pollutants.

- Benzene is the only pollutant of interest for LEKY to appear on all three lists in Table 12-7. 1,3-Butadiene ranks fourth for its toxicity-weighted emissions but is not among the highest emitted in Fayette County. The remaining pollutants of interest for LEKY do not appear on either emissions-based list for Fayette County

12.5 Summary of the 2015-2016 Monitoring Data for the Kentucky Monitoring Sites

Results from several of the data analyses described in this section include the following:

- ❖ *Six monitoring sites sampled for VOCs; five monitoring sites sampled for PM_{10} metals; one monitoring site sampled for carbonyl compounds and PAHs. VOC sampling at the LEKY site was discontinued at the end of July 2016.*

- ❖ *The number of pollutants failing screens for the Kentucky sites varies from five (ASKY-M, BAKY) to 13 (four sites).*

- ❖ *ASKY-M has the highest annual average concentrations of arsenic among NMP sites sampling PM_{10} metals, similar to 2013 and 2014. BAKY and LEKY are also among NMP sites with the highest annual average concentrations of arsenic.*

- ❖ *Some of the highest concentrations of VOCs were measured at the Calvert City sites, particularly vinyl chloride, carbon tetrachloride, 1,3-butadiene, and 1,2-dichloroethane. TVKY has the highest annual average concentration of 1,3-butadiene, carbon tetrachloride, 1,2-dichloroethane, and 1,1,2-trichloroethane among NMP sites sampling VOCs. Further, the annual averages for all three Calvert*

City sites rank among the highest calculated for carbon tetrachloride and 1,2-dichloroethane.

- *The most notable trends in concentrations are shown for GLKY. Concentrations of 1,3-butadiene and 1,2-dichloroethane measured at GLKY exhibit a decreasing trend while concentrations of formaldehyde exhibit an increasing trend at this site. Concentrations of 1,3-butadiene measured at BLKY also exhibit a decreasing trend. Benzene and 1,3-butadiene concentrations measured at some Kentucky sites also appear to have a decreasing trend, but the concentrations measured over the years have been highly variable.*

- *The cancer risk approximation for 1,2-dichloroethane for TVKY is the second highest cancer risk approximation calculated among site-specific pollutants of interest.*

13.0 Site in Massachusetts

This section summarizes those data from samples collected at the NATTS site in Massachusetts and generated by ERG, EPA's contract laboratory for the NMP, over the 2015 and 2016 monitoring efforts. This section also examines the spatial and temporal characteristics of the ambient monitoring concentrations and reviews them through the context of risk. Readers are encouraged to refer to Sections 1 through 4 for detailed discussions and definitions regarding the various data analyses presented below.

Data generated by sources other than ERG, EPA's contract laboratory for the NMP, are not included in the data analyses contained in this report.

13.1 Site Characterization

This section characterizes the BOMA monitoring site by providing a description of the nearby area surrounding the monitoring site; plotting emissions sources surrounding the monitoring site; and presenting traffic data and other characterizing information for the site. This information is provided to give the reader insight regarding factors that may influence the air quality near the site and assist in the interpretation of the ambient measurements.

The BOMA monitoring site is located in Boston. Figure 13-1 presents a composite satellite image retrieved from ArcGIS Explorer showing the monitoring site and its immediate surroundings. Figure 13-2 identifies nearby point source emissions locations by source category, as reported in the 2014 NEI for point sources, version 1. Note that only sources within 10 miles of the site are included in the facility counts provided in Figure 13-2. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have a direct effect on the air quality at the monitoring site. Further, this boundary provides both the proximity of emissions sources to the monitoring site as well as the quantity of such sources within a given distance of the site. Sources outside the 10-mile boundary are still visible on the map for reference but have been grayed out to emphasize emissions sources within the boundary. Table 13-1 provides supplemental geographical information such as land use, location setting, and locational coordinates. Each figure and table is discussed in detail in the paragraphs that follow.

Figure 13-1. Boston, Massachusetts (BOMA) Monitoring Site

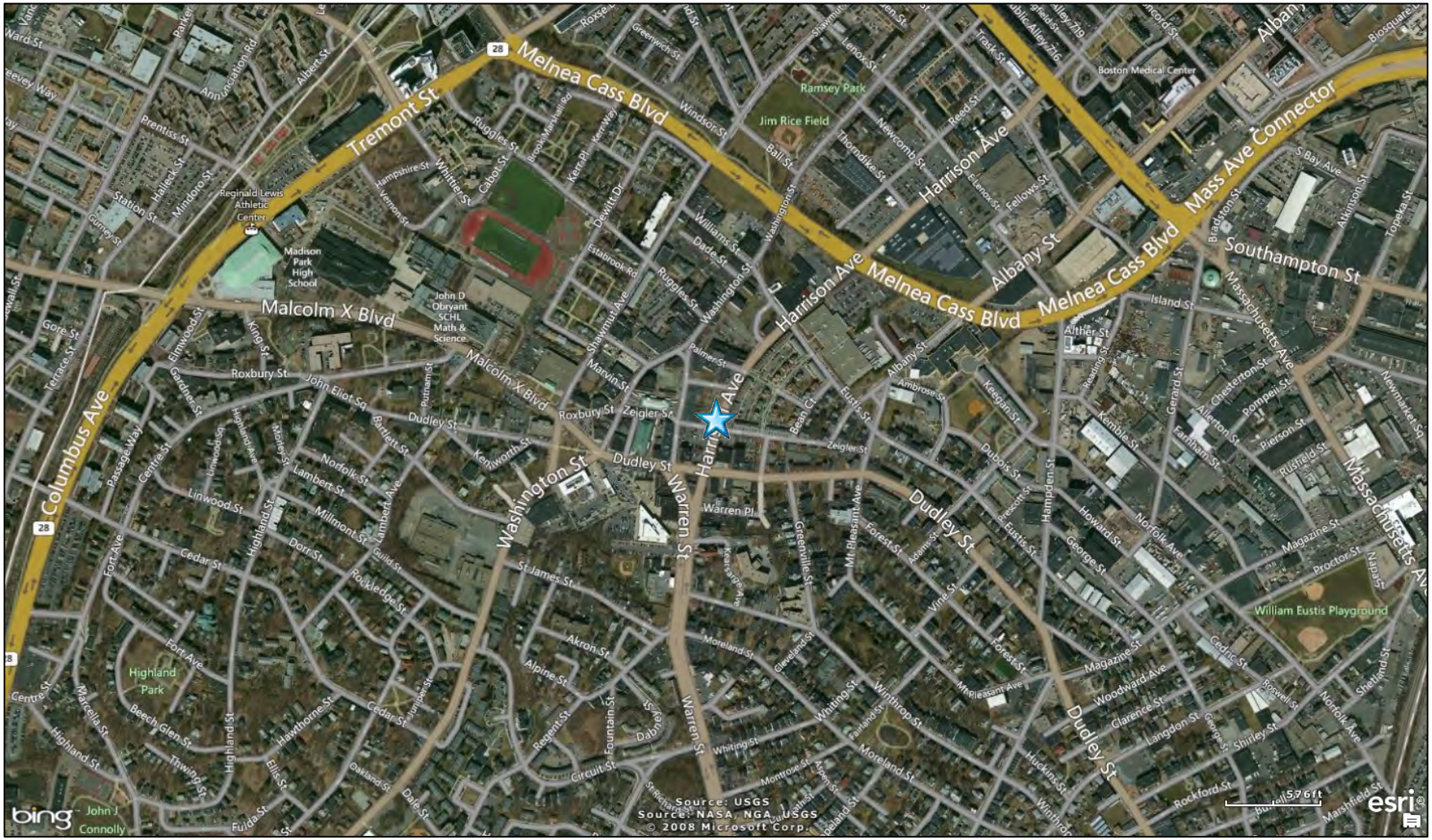


Figure 13-2. NEI Point Sources Located Within 10 Miles of BOMA

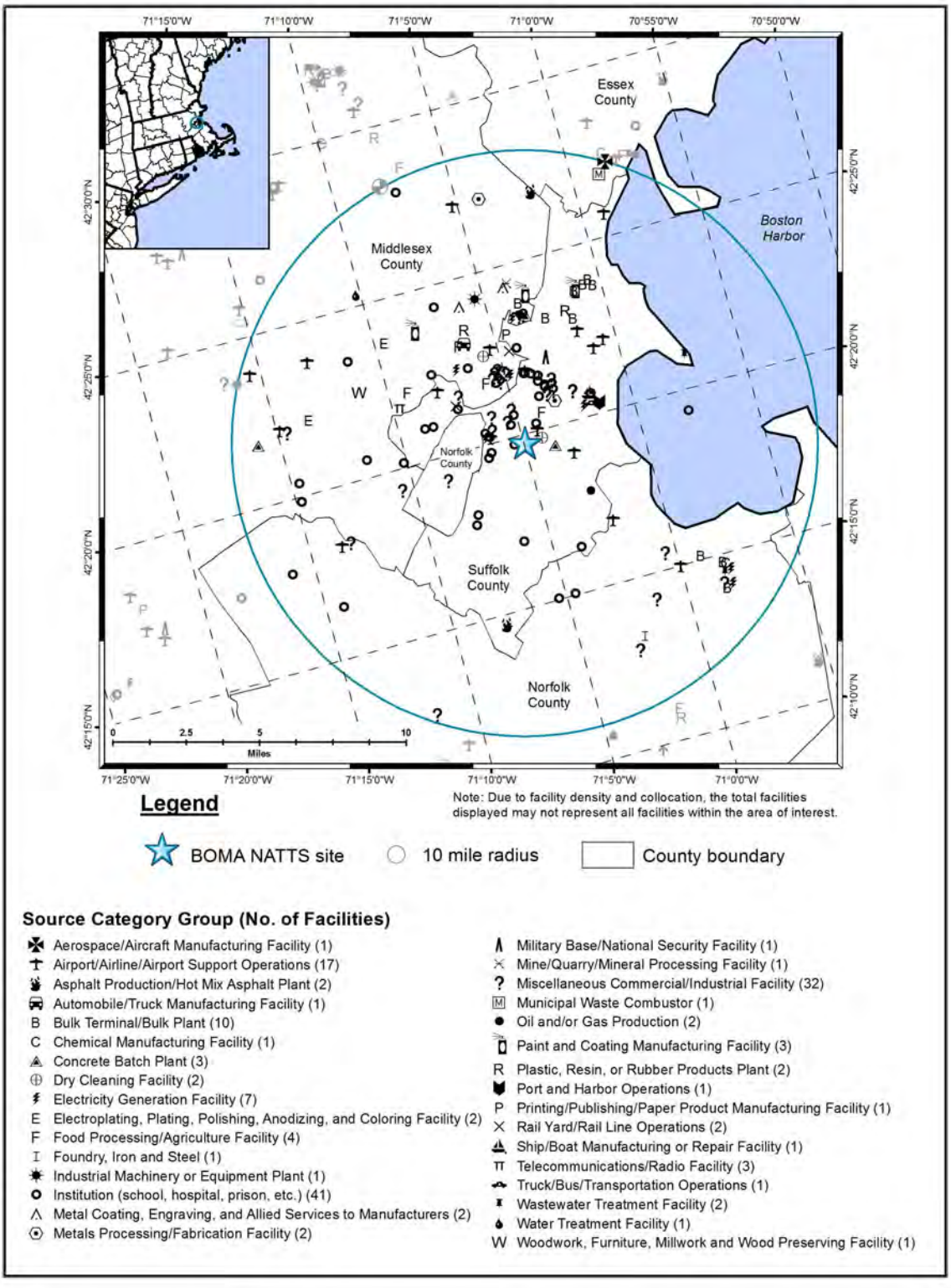


Table 13-1. Geographical Information for the Massachusetts Monitoring Site

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Annual Average Daily Traffic[1]	Intersection Used for Traffic Data
BOMA	25-025-0042	Boston	Suffolk	Boston-Cambridge-Newton, MA-NH	42.329500, -71.082600	Commercial	Urban/City Center	27,654	Melnea Cass Blvd near Shawmut Ave

[1]AADT reflects 2010 data (MA DOT, 2010)
BOLD ITALICS = EPA-designated NATTS Site

The BOMA monitoring site is located at Dudley Square in Roxbury, a southwest neighborhood of Boston, and is the Roxbury NATTS site. The surrounding area is commercial as well as residential, as shown in Figure 13-1. Immediately to the east of the monitoring site are town homes, to the north is a parking lot and to the west are commercial properties. The original purpose for the location of this site was to measure population exposure to emissions from a city bus terminal located another block west of the monitoring site, though buses servicing the area have since been converted to compressed natural gas (CNG). The monitoring site is 1.3 miles south of I-90 and 1 mile southwest of I-93.

As Figure 13-2 shows, BOMA is located near a large number of point sources, with a high density of sources located a few miles to the west, northwest, and north of the site. The source category with the highest number of emissions sources surrounding BOMA is the institutions category, which includes schools, hospitals, and prisons. There are also numerous airport and airport support operations, which include airports and related operations as well as small runways and heliports, such as those associated with hospitals or television stations. Sources located within 1 mile of BOMA include a hospital, a heliport at a hospital, a university, a high school, a dry cleaning facility, and a large apartment building. Figure 13-2 shows that BOMA is located less than 2 miles from the shoreline (Dorchester Bay).

In addition to providing city, county, CBSA, and land use/location setting information, Table 13-1 also contains traffic volume information for the site as well as the location for which the traffic volume was obtained. This information is provided because emissions from motor vehicles can significantly affect concentrations measured at a given monitoring site. The traffic volume experienced near BOMA is greater than 27,000 and in the middle of the range compared to other NMP sites. The traffic estimate provided is for Melnea Cass Boulevard near Shawmut Avenue.

13.2 Pollutants of Interest

The risk-based screening process described in Section 3.2 was performed for each site to identify site-specific “pollutants of interest,” which allows analysts and readers to focus on a subset of pollutants through the context of risk. Each pollutant’s preprocessed daily measurement was compared to its associated risk screening value. If the concentration was greater than the risk screening value, then the concentration “failed the screen.” The site-specific results of this risk-based screening process are presented in Table 13-2 and incorporate measurements from both 2015 and 2016. Pollutants of interest are those for which the individual pollutant’s total failed

screens contribute to the top 95 percent of the site's total failed screens and are shaded in gray in Table 13-2. It is important to note which pollutants were sampled for at each site when reviewing the results of this analysis. PM_{10} metals and PAHs were sampled for at BOMA.

Table 13-2. 2015-2016 Risk-Based Screening Results for the Massachusetts Monitoring Site

Pollutant	Screening Value (µg/m^3)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Boston, Massachusetts - BOMA						
Arsenic (PM_{10})	0.00023	94	118	79.66	48.45	48.45
Naphthalene	0.029	79	121	65.29	40.72	89.18
Nickel (PM_{10})	0.0021	11	118	9.32	5.67	94.85
Cadmium (PM_{10})	0.00056	3	118	2.54	1.55	96.39
Benzo(a)pyrene	0.00057	2	117	1.71	1.03	97.42
Lead (PM_{10})	0.015	2	118	1.69	1.03	98.45
Acenaphthene	0.011	1	102	0.98	0.52	98.97
Fluoranthene	0.011	1	121	0.83	0.52	99.48
Fluorene	0.011	1	83	1.20	0.52	100.00
Total		194	1,016	19.09		

Observations from Table 13-2 include the following:

- Concentrations of nine pollutants failed at least one screen for BOMA; approximately 19 percent of concentrations for these nine pollutants were greater than their associated risk screening value (or failed screens). Of these nine pollutants, six failed three screens or less.

- Four pollutants contributed to 95 percent of failed screens for BOMA and therefore were identified as pollutants of interest for this site. These include three PM_{10} metals (arsenic, nickel, and cadmium) and one PAH (naphthalene).

- Together, arsenic and naphthalene account for nearly 90 percent of the total failed screens for BOMA while nickel and cadmium account for 7 percent of the total failed screens. BOMA is one of only two NMP sites for which cadmium is a pollutant of interest.

For each of the data analyses described in the remaining sections, the focus is on the site-specific pollutants of interest identified via the risk-based screening process, as described in Section 3.4.2.

13.3 Concentrations

This section presents various concentration averages used to characterize air toxics concentration levels at the Massachusetts monitoring site. Where applicable, the following calculations and data analyses were performed for each of the site-specific pollutants of interest:

- Time period-based concentration averages (quarterly and annual) are provided for each monitoring site for each year.
- The range of measurements and annual average concentrations are presented graphically to illustrate how each site's concentrations compare to the program-level averages, as presented in Section 4.1.
- Concentration averages and other statistical metrics for 2015, 2016, and from previous years of monitoring are presented in order to characterize concentration trends at the site.

Each data analysis is performed where the applicable criteria are met (as specified in the appropriate sections discussed below) and is limited to the site-specific pollutants of interest. However, site-specific statistical summaries for all pollutants sampled for at BOMA are provided in Appendices N and O.

13.3.1 2015 and 2016 Concentration Averages

Quarterly and annual concentration averages for 2015 and 2016 were calculated for the pollutants of interest for BOMA, as described in Section 3.1. The *quarterly average concentration* of a particular pollutant is simply the average concentration of the preprocessed daily measurements over a given calendar quarter. Quarterly average concentrations include the substitution of zeros for all non-detects. A site must have a minimum of 75 percent valid samples compared to the total number of samples possible within a given calendar quarter for a quarterly average to be calculated. An *annual average concentration* includes all measured detections and substituted zeros for non-detects for an entire year of sampling. Annual averages were calculated for pollutants where three valid quarterly averages could be calculated for a given year and where method completeness was greater than or equal to 85 percent, as presented in Section 2.4. Quarterly and annual average concentrations for the pollutants of interest for BOMA are presented in Table 13-3, where applicable. Note that if a pollutant was not detected in a given calendar quarter, the quarterly average simply reflects "0" because only zeros substituted for non-detects were factored into the quarterly average concentration.

Table 13-3. Quarterly and Annual Average Concentrations of the Pollutants of Interest for the Massachusetts Monitoring Site

Pollutant	2015						2016					
	# of Detects/ # >MDL/ # Samples	Q1 Avg (ng/m^3)	Q2 Avg (ng/m^3)	Q3 Avg (ng/m^3)	Q4 Avg (ng/m^3)	Annual Average (ng/m^3)	# of Detects/ # >MDL/ # Samples	Q1 Avg (ng/m^3)	Q2 Avg (ng/m^3)	Q3 Avg (ng/m^3)	Q4 Avg (ng/m^3)	Annual Average (ng/m^3)
Boston, Massachusetts – BOMA												
Arsenic (PM_{10})	60/56/60	0.38 ± 0.09	0.84 ± 0.75	0.63 ± 0.23	0.36 ± 0.11	0.55 ± 0.19	58/58/58	0.40 ± 0.13	0.55 ± 0.22	0.47 ± 0.12	0.55 ± 0.18	0.48 ± 0.08
Cadmium (PM_{10})	60/60/60	0.11 ± 0.03	0.08 ± 0.02	0.08 ± 0.02	0.08 ± 0.02	0.09 ± 0.01	58/58/58	0.08 ± 0.02	0.26 ± 0.38	0.06 ± 0.01	0.52 ± 0.83	0.22 ± 0.21
Naphthalene	60/60/60	41.85 ± 9.91	35.58 ± 6.96	50.17 ± 8.37	37.70 ± 9.41	41.12 ± 4.36	61/61/61	29.91 ± 9.78	29.11 ± 4.41	35.34 ± 7.37	38.06 ± 8.39	33.05 ± 3.80
Nickel (PM_{10})	60/60/60	1.79 ± 0.58	1.01 ± 0.15	0.85 ± 0.13	0.68 ± 0.19	1.08 ± 0.19	58/58/58	0.98 ± 0.36	1.04 ± 0.42	1.31 ± 0.39	6.93 ± 10.04	2.52 ± 2.36

Observations for BOMA from Table 13-3 include the following:

- Naphthalene is the pollutant with the highest annual average concentrations among BOMA's pollutants of interest. Among the metals, nickel has the highest annual average concentrations, followed by arsenic and then cadmium.

- Concentrations of naphthalene measured at BOMA range from 12.8 ng/m^3 to 93.9 ng/m^3. Concentrations of naphthalene appear higher in 2015 than in 2016, based on the quarterly and annual average concentration shown in Table 13-3. A review of the data shows that the number of naphthalene concentrations greater than 50 ng/m^3 is considerably less for 2016 (3) than 2015 (17). However, the confidence intervals indicate that the difference is not statistically significant.

- Concentrations of arsenic measured at BOMA range from 0.001 ng/m^3 to 5.83 ng/m^3, which is the third highest arsenic concentration measured across the program. The highest and second highest (1.83 ng/m^3) arsenic concentrations measured at BOMA were measured on back-to-back sample days in 2015 (June 29 and July 5). The effects of the maximum concentration are evident in the second quarter average concentration for 2015 (0.84 ± 0.75 ng/m^3). The confidence interval for this quarterly average is nearly the same magnitude as the concentration itself, indicating a high level of variability, outliers, or both. Both the minimum and maximum arsenic concentrations were measured at BOMA during this calendar quarter. Further, BOMA's minimum arsenic concentration is the lowest measured detection of this pollutant across the program (and only three arsenic measurements across the program are less than 0.01 ng/m^3, plus the five non-detects).

- Concentrations of nickel measured at BOMA range from 0.314 ng/m^3 to 69.5 ng/m^3, which is the maximum nickel concentration measured across the program. This measurement is more than three times greater than the next highest concentration measured at a NMP site sampling PM_{10} metals and seven times greater than the next highest concentration measured at BOMA (both of which were measured in November 2016). The effects of this outlier on the quarterly and annual average concentrations is evident in Table 13-3. The confidence interval for the fourth quarter average for 2016 is greater than the average itself and the confidence interval for the annual average is similar in magnitude to the average itself.

- Concentrations of cadmium measured at BOMA range from 0.021 ng/m^3 to 5.70 ng/m^3, which is the second highest cadmium concentration measured across the program. The fourth highest cadmium concentration across the program was also measured at BOMA (2.43 ng/m^3). BOMA is one of only three NMP sites at which cadmium concentrations greater than 2 ng/m^3 were measured. The calendar quarters in which these higher concentrations were measured can be seen in the quarterly averages in Table 13-3. The quarterly and annual average concentrations of cadmium for 2015 are all around 0.10 ng/m^3. This is also true for the first and third quarter averages for 2016, while the second and fourth quarter averages for 2016 are several times higher and have confidence intervals similar to or greater than the average itself (and the confidence interval for the annual average for 2016 is also similar in magnitude to the average itself). Of the 11 nickel concentrations measured at BOMA greater than 2 ng/m^3, eight were measured in 2016.

- Table 4-12 presents the NMP sites with the 10 highest annual average concentrations for the only program-level PAH pollutants of interest and Table 4-13 presents the NMP sites with the 10 highest annual average concentrations for the only program-level speciated metals pollutant of interest (arsenic). BOMA does not appear in either table for naphthalene or arsenic.

13.3.2 Concentration Comparison

In order to better illustrate how each site's annual average concentrations compare to the program-level averages, a site-specific box plot was created for each of the site-specific pollutants of interest, where applicable. Thus, box plots were created for each of the pollutants listed in Table 13-3 for BOMA. Figures 13-3 through 13-6 overlay the site's minimum, annual average, and maximum concentrations for each year onto the program-level minimum, first quartile, median, average, third quartile, and maximum concentrations, as described in Section 3.4.2.1, and are discussed below. If an annual average concentration could not be calculated, the range of concentrations is still provided in the figures that follow.

Figure 13-3. Program vs. Site-Specific Average Arsenic (PM_{10}) Concentrations

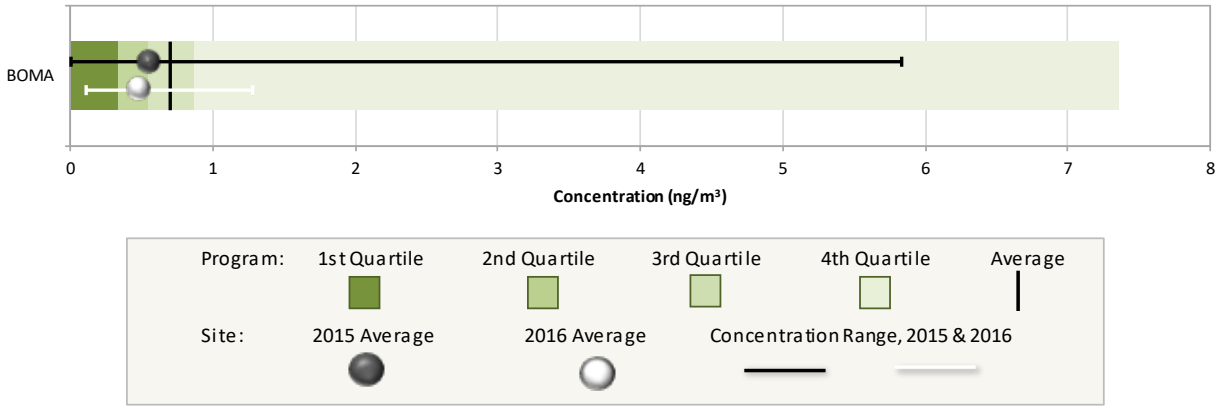


Figure 13-3 presents the box plot for arsenic for BOMA and shows the following:

- The range of arsenic concentrations measured in 2015 appears considerably larger than the range of arsenic concentrations measured in 2016. If the maximum concentration of arsenic measured at BOMA in 2015 is excluded, the range for 2015 would still be larger than the range measured in 2016, but the difference between the two would be much smaller (the second highest concentration measured in 2015 is 1.83 ng/m^3). The maximum arsenic concentration measured at BOMA is the third highest arsenic concentration measured across the program.

- Both annual average arsenic (PM_{10}) concentrations for BOMA are less than the program-level average concentration (0.70 ng/m^3); the annual average for 2015 is the same as the program-level median concentration (0.55 ng/m^3), while the annual average for 2016 is slightly less than the program-level median.

Figure 13-4. Program vs. Site-Specific Average Cadmium (PM_{10}) Concentrations

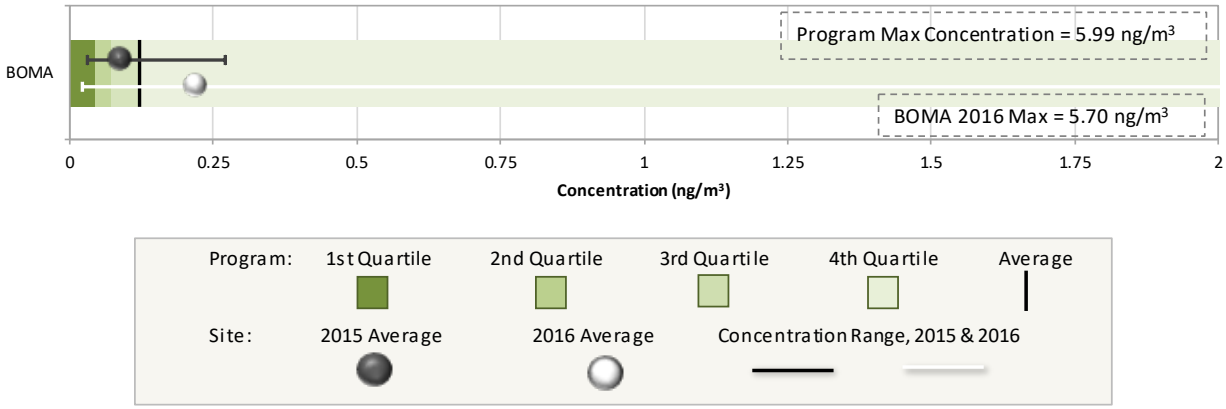


Figure 13-4 presents the box plot for cadmium for BOMA and shows the following:

- The program-level maximum cadmium concentration (5.99 ng/m^3) is not shown directly on the box plot because the scale of the box plot would be too large to readily observe data points at the lower end of the concentration range. Thus, the scale of the box plot has been reduced to 2 ng/m^3. Since the maximum cadmium concentration measured at BOMA is also greater than the scale of the box plot, this concentration is also labeled in the box plot.

- While not the maximum concentration measured across the program, the maximum cadmium concentration measured at BOMA is just slightly less, and is the second highest cadmium concentration measured across the program. The second highest cadmium concentration measured at BOMA (2.43 ng/m^3) was also measured in 2016, and also exceeds the scale of the box plot.

- BOMA's annual average concentrations of cadmium for 2015 is less than the program-level average concentration (0.12 ng/m^3), while the annual average concentrations for 2016 is nearly twice the program-level average.

Figure 13-5. Program vs. Site-Specific Average Naphthalene Concentrations

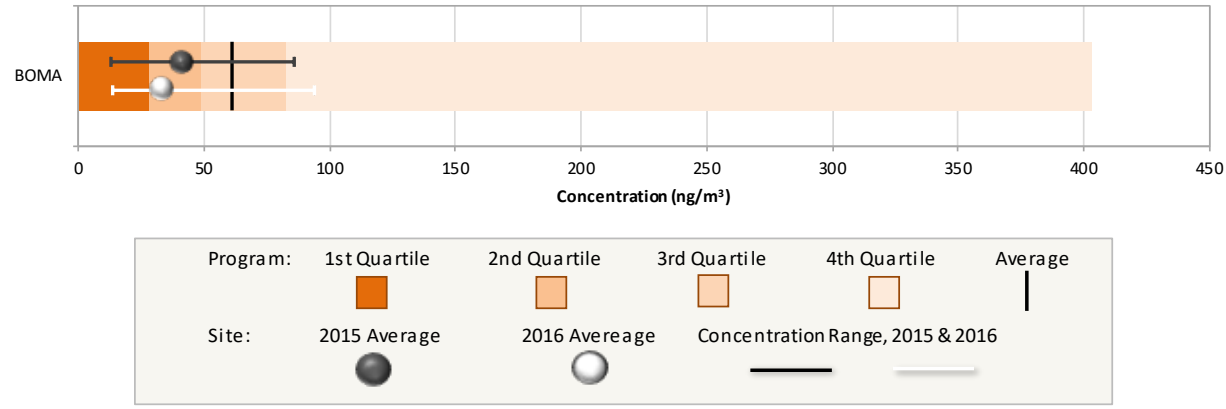


Figure 13-5 presents the box plot for naphthalene for BOMA and shows the following:

- The range of naphthalene concentrations measured at BOMA in 2015 is fairly similar to the range of naphthalene concentrations measured at BOMA in 2016, both of which are considerably smaller than the range of concentrations measured across the program.

- The annual average naphthalene concentration for 2015 is just slight higher than the annual average naphthalene concentration for 2016, and both are less than the program-level average concentration (61.23 ng/m^3) and the program-level median concentration (48.90 ng/m^3).

Figure 13-6. Program vs. Site-Specific Average Nickel (PM_{10}) Concentrations

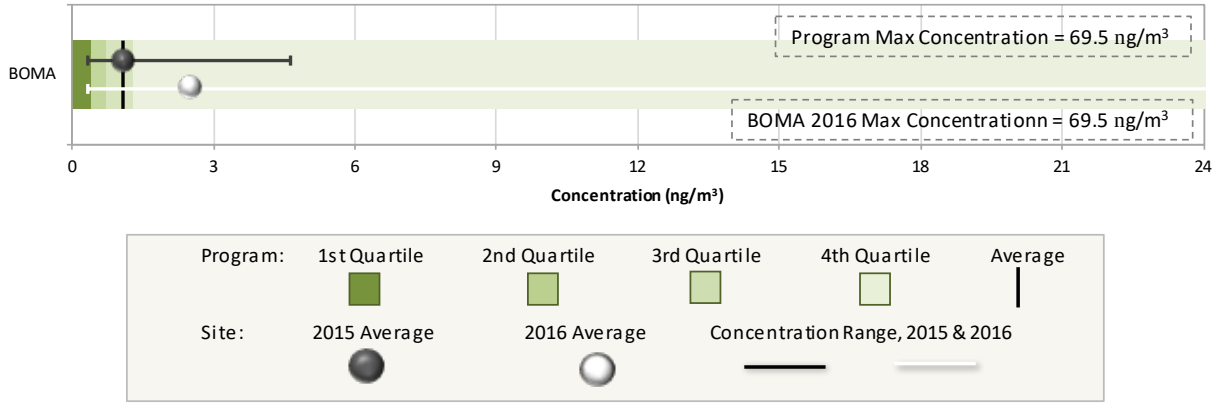


Figure 13-6 presents the box plot for nickel for BOMA and shows the following:

- Similar to cadmium, the program-level maximum nickel concentration (69.5 ng/m^3) is not shown directly on the box plot because the scale of the box plot would be too large to readily observe data points at the lower end of the concentration range. Thus, the scale of the box plot has been reduced. Since the maximum nickel concentration measured at BOMA is the maximum nickel concentration measured across the program, this is also labeled in the box plot.

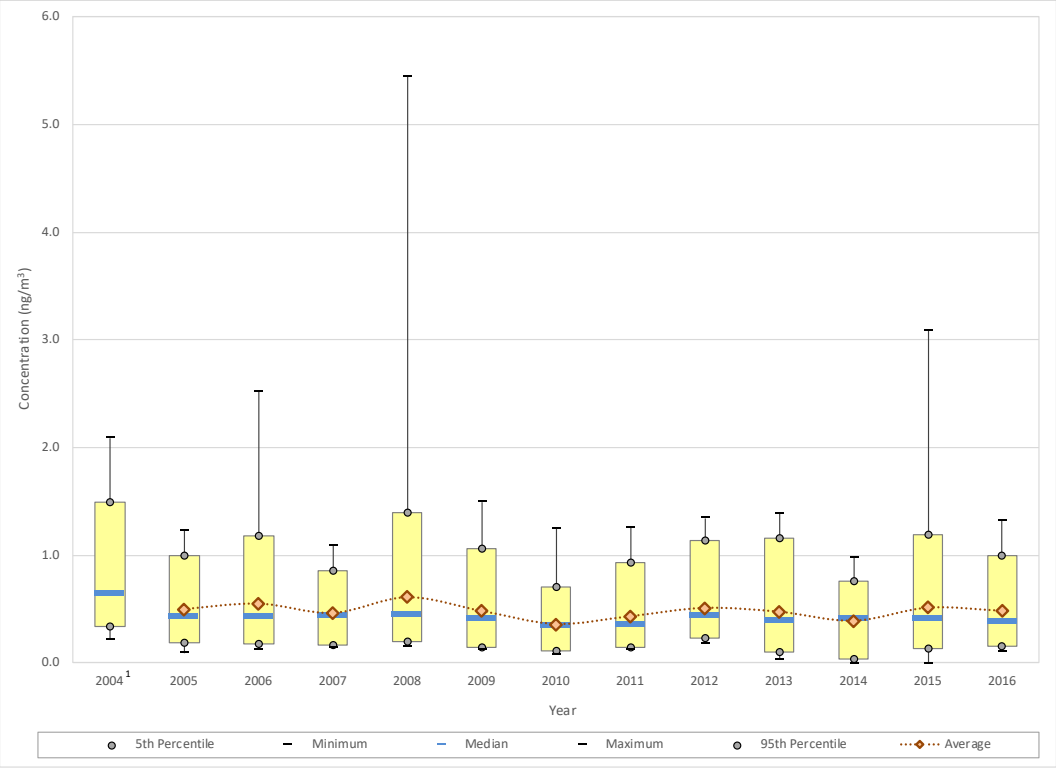
- BOMA's maximum nickel concentration of 69.5 ng/m^3 is the highest nickel concentration measured across the program. The next two highest nickel concentrations measured at BOMA (8.40 ng/m^3 and 7.20 ng/m^3, also measured in 2016), are an order of magnitude less.

- The annual average concentration of nickel for 2015 is similar to the program-level average concentration of 1.09 ng/m^3. The annual average concentration for 2016 is more than twice the program-level average concentration.

13.3.3 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the pollutants of interest for 5 consecutive years or longer, as described in Section 3.4.2.2. BOMA has sampled PM_{10} metals under the NMP since 2003 and PAHs since 2008. Thus, Figures 13-7 through 13-10 present the 1-year statistical metrics for each of the pollutants of interest for BOMA. The statistical metrics presented for assessing trends include the substitution of zeros for non-detects. If sampling began mid-year, a minimum of 6 months of sampling is required for inclusion in the trends analysis; in these cases, a 1-year average concentration is not provided, although the range and percentiles are still presented. Note that the concentrations from collocated analyses are averaged together for this trends analysis, as indicated in Section 3.4.2.2, and may result in some differences from the previous sections. This is particularly true for BOMA metals, where collocated samples account for more than half of the sampling events at this site.

Figure 13-7. Yearly Statistical Metrics for Arsenic (PM_{10}) Concentrations Measured at BOMA



[1] A 1-year average is not presented because there were breaks in sampling during portions of 2004.

Observations from Figure 13-7 for arsenic concentrations measured at BOMA include the following:

- Although sampling for PM_{10} metals under the NMP began in 2003, data from that year were excluded from this analysis because sampling did not begin until October. In addition, samples were not collected during portions of April, May, September, and October 2004. Because a full year's worth of data is not available for 2004, a 1-year average concentration is not presented, although the range of measurements is provided.

- The maximum arsenic concentration shown was measured on July 5, 2008 (5.45 ng/m^3). Three additional concentrations greater than 2 ng/m^3 have been measured at BOMA, one each in 2004, 2006, and 2015.

- The 1-year average concentrations of arsenic have fluctuated over the years, ranging from 0.36 ng/m^3 (2010) to 0.61 ng/m^3 (2008). For 2008, the maximum concentration is driving the 1-year average upward, which is evident from the median concentration, which hardly changed between 2007 and 2008, even though the smallest range of measurements was collected in 2007. If the maximum concentration for 2008 was removed from the dataset, the 1-year average concentration for 2008 would decrease from 0.61 ng/m^3 to 0.53 ng/m^3, making the changes in the 1-year averages between 2007 and 2009 more subtle.

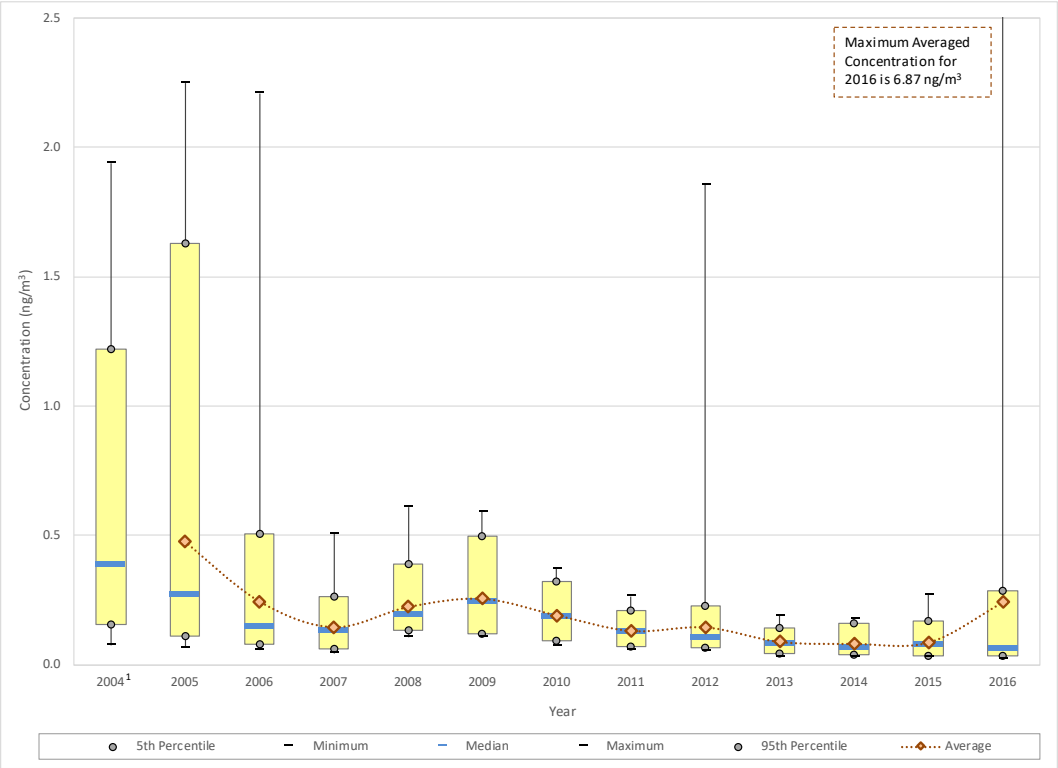
- All of the statistical metrics exhibit a decrease from 2008 to 2009 and again for 2010, when both central tendency parameters are at a minimum. Conversely, all of the statistical metrics exhibit an increase from 2010 to 2011 and again for 2012.

- For 2013, a higher number of concentrations at the lower end of the concentration range were measured while concentrations at the top of the range changed little. The number of arsenic concentrations less than 0.25 ng/m^3 increased from one in 2012 to 16 for 2013. This is explains the considerable decrease in the minimum and 5th percentile shown for 2013, as well as the slight decreases in the 1-year average and median concentrations. The number of arsenic concentrations less than 0.25 ng/m^3 also increased for 2014 (18) and a non-detect was measured for the first (and only) time. The maximum arsenic concentration measured at BOMA in 2014 is less than 1 ng/m^3 for the first time since the onset of sampling.

- Most of the statistical parameters exhibit increases for 2015, although the median did not change. Even the minimum concentration increased, as there were no non-detects measured in 2015, although this is difficult to discern, as this is the lowest measured detection of arsenic.

- The differences in the statistical parameters for 2015 and 2016 are greatly reduced if the minimum and maximum concentrations measured in 2015 are removed from the dataset.

Figure 13-8. Yearly Statistical Metrics for Cadmium (PM_{10}) Concentrations Measured at BOMA



[1] A 1-year average is not presented because there were breaks in sampling during portions of 2004.

Observations from Figure 13-8 for cadmium concentrations measured at BOMA include the following:

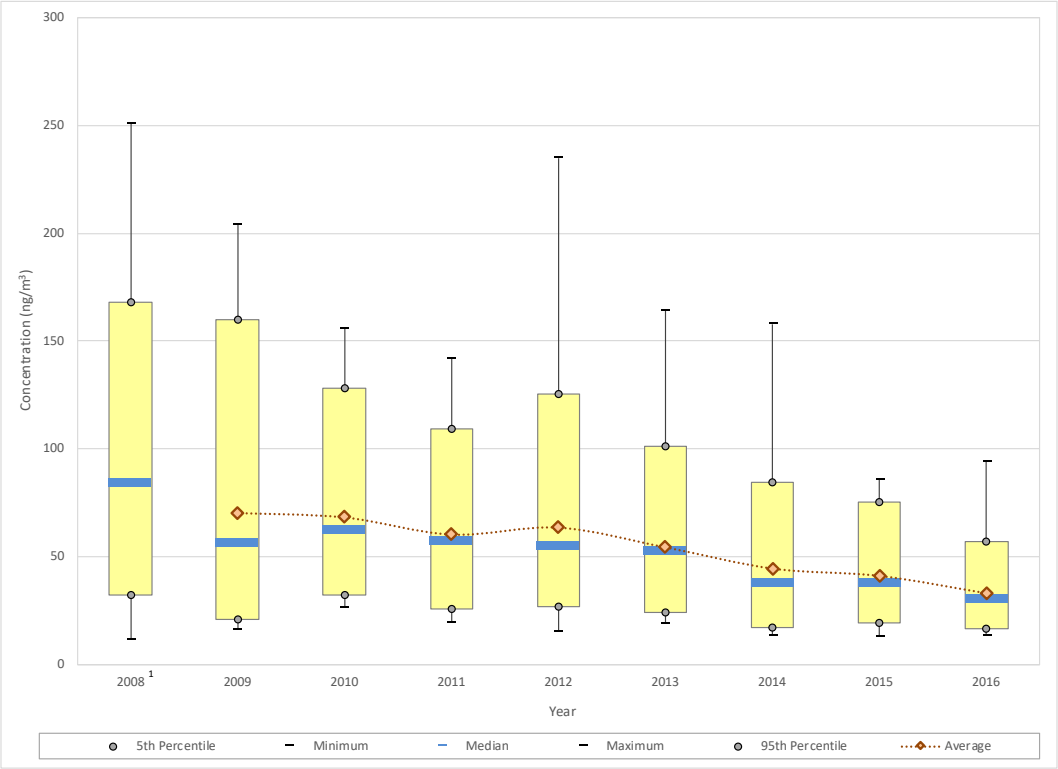
- Cadmium concentrations of higher magnitude were measured often during the early years of sampling. Cadmium concentrations greater than 0.5 ng/m^3 account for more than 30 percent of measurements in 2004 and 2005, and account for approximately five percent or less for each of the following years, including several years when none were measured.

- A significant decreasing trend is shown between 2005 and 2007, which is followed an increasing trend through 2009. A second decreasing trend is shown afterward and, with the exception of 2012, continued through 2014. If the maximum concentration measured in 2012 was removed from the dataset, the 1-year average concentration would have a continuous decreasing trend over this 5-year period. Only slight changes are shown for 2015.

- While the maximum concentration measured in 2016 is driving the 1-year average concentration upward, it is not the sole reason for the increases shown, as the 95th percentile is at its highest since 2010. Two of the three highest cadmium concentrations were measured at BOMA in 2016. However, the median cadmium concentration is at a minimum over the period of sampling. The number of cadmium concentrations less than 0.06 ng/m^3 has increased at BOMA in recent years; three or

fewer of these concentrations were measured prior to 2013. By 2016, concentrations less than 0.06 ng/m^3 account for 45 percent of the measurements.

Figure 13-9. Yearly Statistical Metrics for Naphthalene Concentrations Measured at BOMA



[1] A 1-year average is not presented because sampling under the NMP did not begin until May 2008.

Observations from Figure 13-9 for naphthalene concentrations measured at BOMA include the following:

- BOMA began sampling PAHs under the NMP in May 2008. Because a full year's worth of data is not available for 2008, a 1-year average concentration is not presented, although the range of measurements is provided.

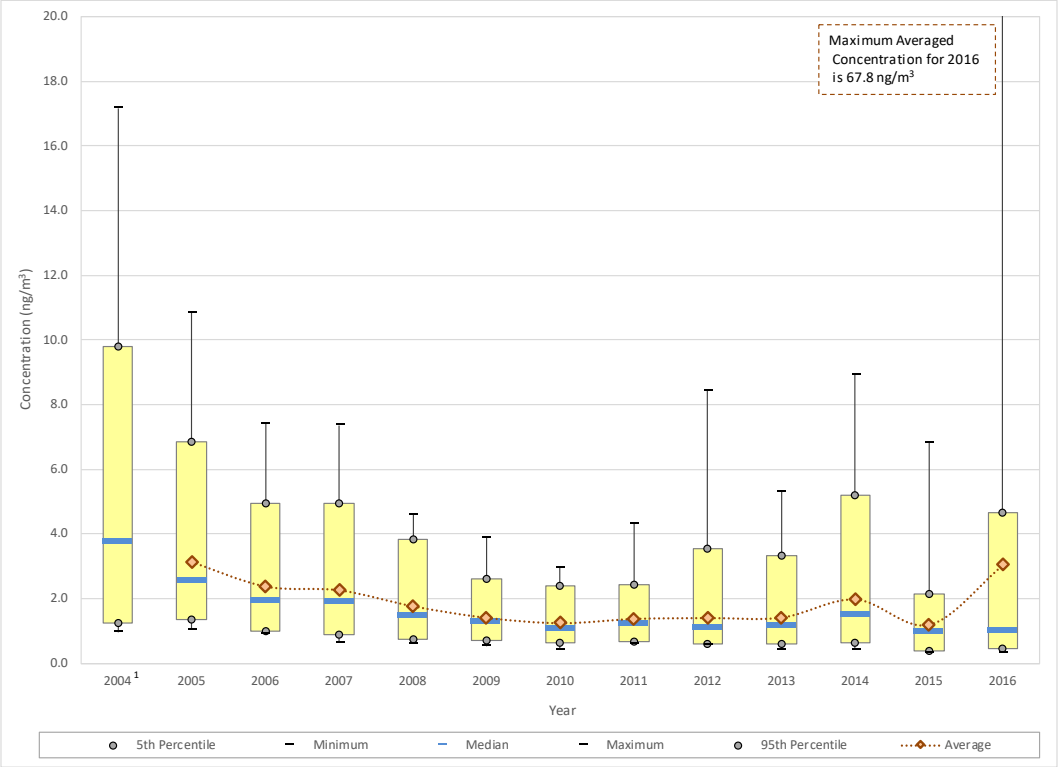
- The maximum naphthalene concentration (251 ng/m^3) was measured at BOMA on the very first sample day (May 6, 2008), although a similar measurement was also collected in 2012 (235 ng/m^3). Two additional concentrations greater than 200 ng/m^3 have been measured at BOMA (another in 2008 and one in 2009).

- The median concentration exhibits a considerable decrease from 2008 to 2009, which is the first full-year of sampling. This is due to the increase of naphthalene concentrations at the lower end of the concentration range. The number of naphthalene concentrations less than 50 ng/m^3 increased from six measured in 2008 to 23 measured in 2009, accounting for nearly 40 percent of the samples collected in 2009 (compared to 16 percent for 2008).

- Beginning with the first full-year of sampling, the difference between the 5th and 95th percentiles (the range of concentrations within which 90 percent of the measurements lie) decreased each year through 2011. The range increased somewhat for 2012 and is more similar to the range shown for 2010, before decreasing further each year afterward and reaching a minimum in 2016.

- Naphthalene concentrations have a significant decreasing trend at BOMA. Excluding 2012, the 1-year average concentration has decreased each year at BOMA, decreasing from 70.33 ng/m^3 for 2009 to 33.05 ng/m^3 for 2016. (If the maximum concentration measured in 2012 was excluded from the dataset, the 1-year average concentration would exhibit little change from 2011 to 2012.)

Figure 13-10. Yearly Statistical Metrics for Nickel (PM_{10}) Concentrations Measured at BOMA



[1] A 1-year average is not presented because there were breaks in sampling during portions of 2004.

Observations from Figure 13-10 for nickel concentrations measured at BOMA include the following:

- The maximum nickel concentration measured at BOMA prior to 2016 is 17.2 ng/m^3 (measured in 2004). Nickel concentrations two and four times greater than this measurement were measured at BOMA in 2016.

- A steady decreasing trend in nickel concentrations measured at BOMA is shown through 2010. Concentrations for 2011 increased just slightly, returning to 2009 levels. Even with the higher concentrations measured in 2012 and 2013, the 1-year average concentration did not change significantly from 2011. Between 2009 and 2013, less than 0.2 ng/m^3 separates the 1-year average concentrations.

- Considerable increases, however, are shown for 2014, as all of the statistical parameters exhibit increases, except the minimum concentration, which did not change. Three nickel concentrations measured in 2014 are greater than the maximum nickel concentration measured in 2013. Further, the number nickel concentrations greater than 2 ng/m^3 measured at BOMA in 2014 is at its highest since 2008.

- All of the statistical parameters exhibit decreases for 2015, when the 1-year average concentration is at a minimum. The number of nickel concentrations greater than 2 ng/m^3 measured at BOMA in 2015 is at a minimum over the years of sampling.

- All of the statistical parameters exhibit increases for 2016, when the 1-year average concentration is at a maximum. The maximum nickel concentrations increased by an order of magnitude from 2015 to 2016 and the 1-year average and 95th percentile more than doubled. Yet, the median concentration changed little, indicating that the measurements on the higher end of the concentration range are driving some of these changes. If the two highest concentrations were removed from the dataset, the statistical parameters would still exhibit increases for 2016, though they would be more subtle.

13.4 Additional Risk-Based Screening Evaluations

The following risk-based screening evaluations were conducted to characterize risk related to the air toxics measured at the BOMA monitoring site. Refer to Sections 3.2, 3.4.2.3, and 3.4.2.4 for definitions and explanations regarding the various toxicity factors, time frames, and calculations associated with these risk-based screenings.

13.4.1 Cancer Risk and Noncancer Hazard Approximations

For the pollutants of interest for BOMA, risk was examined by calculating cancer risk and noncancer hazard approximations for each year annual average concentrations could be calculated. These approximations can be used as risk estimates for cancer and noncancer effects attributable to the pollutants of interest. Although the use of these approximations is limited, they may help identify where policy-makers want to shift their air-monitoring priorities. Refer to Section 3.4.2.3 for an explanation of how cancer risk and noncancer hazard approximations are calculated and what limitations are associated with them. Annual averages, cancer UREs and/or noncancer RfCs, and cancer risk and noncancer hazard approximations are presented in Table 13-4, where applicable. Cancer risk approximations are presented as probabilities while the noncancer hazard approximations are ratios and thus, unitless values.

Observations for BOMA from Table 13-4 include the following:

- Among the pollutants of interest for BOMA, naphthalene has the highest annual average concentrations while cadmium has the lowest annual average concentrations.
- Arsenic has the highest cancer risk approximations among the pollutants of interest for BOMA, both of which are greater than 2 in-a-million (2.38 in-a-million for 2015 and 2.08 in-a-million for 2016).
- None of the pollutants of interest for BOMA have noncancer hazard approximations greater than 1.0; in fact, none of the pollutants of interest have noncancer hazard approximations greater than 0.05. This indicates that adverse noncancer health effects are not expected due to these individual pollutants.

Table 13-4. Risk Approximations for the Massachusetts Monitoring Site

Pollutant	Cancer URE ($\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	2015				2016			
			# of Measured Detections vs. # of Samples	Annual Average (ng/m^3)	Risk Approximations		# of Measured Detections vs. # of Samples	Annual Average (ng/m^3)	Risk Approximations	
					Cancer (in-a-million)	Noncancer (HQ)			Cancer (in-a-million)	Noncancer (HQ)
Boston, Massachusetts - BOMA										
Arsenic (PM_{10})	0.0043	0.000015	60/60	0.55 ± 0.19	2.38	0.04	58/58	0.48 ± 0.08	2.08	0.03
Cadmium (PM_{10})	0.0018	0.00001	60/60	0.09 ± 0.01	0.16	0.01	58/58	0.22 ± 0.21	0.39	0.02
Naphthalene	0.000034	0.003	60/60	41.12 ± 4.36	1.40	0.01	61/61	33.05 ± 3.80	1.12	0.01
Nickel (PM_{10})	0.00048	0.00009	60/60	1.08 ± 0.19	0.52	0.01	58/58	2.52 ± 2.36	1.21	0.03

13.4.2 Risk-Based Emissions Assessment

In addition to the risk-based screening discussed above, this section presents an evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 13-5 presents the 10 pollutants with the highest emissions from the 2014 NEI (version 1) that have cancer toxicity factors. Table 13-5 also presents the 10 pollutants with the highest toxicity-weighted emissions, based on the weighting schema described in Section 3.4.2.4. Lastly, Table 13-5 provides the pollutants with the highest cancer risk approximations (in-a-million) for BOMA, as presented in Table 13-4. Cancer risk approximations for 2015 are presented in green while approximations for 2016 are in white. The emissions, toxicity-weighted emissions, and cancer risk approximations are shown in descending order in Table 13-5. Table 13-6 presents similar information, but is limited to those pollutants with noncancer toxicity factors.

Because not all pollutants have both cancer and noncancer toxicity factors, the highest emitted pollutants in the cancer table may be different from the noncancer table, although the actual quantity of emissions is the same. The cancer risk and noncancer hazard approximations based on each site's annual averages are limited to the pollutants of interest identified for each site. In addition, the cancer risk and noncancer hazard approximations are limited to those pollutants with enough data to meet the criteria for annual averages to be calculated. A more in-depth discussion of this analysis is provided in Section 3.4.2.4. Similar to the cancer risk and noncancer hazard approximations provided in Section 13.4.1, this analysis may help policy-makers prioritize their air monitoring activities.

Table 13-5. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Massachusetts Monitoring Site

Top 10 Total Emissions for Pollutants with Cancer UREs (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Boston, Massachusetts (Suffolk County) - BOMA					
Formaldehyde	128.17	Formaldehyde	1.67E-03	Arsenic	2.38
Benzene	114.93	Benzene	8.96E-04	Arsenic	2.08
Acetaldehyde	59.29	1,3-Butadiene	6.17E-04	Naphthalene	1.40
Ethylbenzene	54.59	Naphthalene	3.32E-04	Nickel	1.21
1,3-Butadiene	20.57	POM, Group 2b	2.10E-04	Naphthalene	1.12
Naphthalene	9.77	Ethylene oxide	1.84E-04	Nickel	0.52
POM, Group 2b	2.39	Arsenic, PM	1.70E-04	Cadmium	0.39
Trichloroethylene	1.79	Ethylbenzene	1.36E-04	Cadmium	0.16
POM, Group 2d	1.50	POM, Group 2d	1.32E-04		
Nickel, PM	0.23	Acetaldehyde	1.30E-04		

[1] Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Table 13-6. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the Massachusetts Monitoring Site

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Hazard Approximation (HQ)**
Boston, Massachusetts (Suffolk County) - BOMA					
Toluene	455.19	Acrolein	586,790.86	Arsenic	0.04
Methanol	340.95	Formaldehyde	13,078.15	Arsenic	0.03
Xylenes	198.99	1,3-Butadiene	10,286.36	Nickel	0.03
Formaldehyde	128.17	Acetaldehyde	6,588.00	Cadmium	0.02
Benzene	114.93	Benzene	3,831.01	Naphthalene	0.01
Hexane	88.55	Naphthalene	3,256.67	Nickel	0.01
Acetaldehyde	59.29	Arsenic, PM	2,639.31	Naphthalene	0.01
Ethylbenzene	54.59	Nickel, PM	2,598.79	Cadmium	0.01
Ethylene glycol	53.76	Cadmium, PM	2,447.43		
Glycol ethers, gas	28.14	Xylenes	1,989.86		

[1] Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Observations from Table 13-5 include the following:

- Formaldehyde, benzene, and acetaldehyde are the highest emitted pollutants with cancer UREs in Suffolk County.

- The pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) are formaldehyde, benzene, and 1,3-butadiene.

- Eight of the highest emitted pollutants in Suffolk County also have the highest toxicity-weighted emissions, with formaldehyde and benzene ranking highest on both emissions-based lists.

- Naphthalene is the only pollutant of interest for BOMA to appear on both emissions-based lists, ranking sixth for quantity emitted and fourth for its toxicity-weighted emissions.

- Among the metal pollutants of interest, nickel ranks 10th highest for its total emissions and arsenic ranks seventh for its toxicity-weighted emissions. Cadmium appears on neither list (ranking 21st for total emissions and 14th for its toxicity-weighted emissions).

- POM, Group 2b appears on both emissions-based lists in Table 13-5. POM, Group 2b includes several PAHs sampled for at BOMA including acenaphthene and fluorene, both of which failed screens. POM, Group 2d appears on both emissions-based lists; POM, Group 2d does not include any PAHs sampled for at BOMA.

Observations from Table 13-6 include the following:

- Toluene, methanol, and xylenes are the highest emitted pollutants with noncancer RfCs in Suffolk County.

- The pollutants with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) are acrolein, formaldehyde, and 1,3-butadiene.

- Four of the highest emitted pollutants in Suffolk County also have the highest toxicity-weighted emissions.

- All four of BOMA's pollutants of interest appear among the pollutants with the highest toxicity-weighted emissions for Suffolk County, although none of these appear among the highest emitted pollutants (with noncancer RfCs).

13.5 Summary of the 2015-2016 Monitoring Data for BOMA

Results from several of the data analyses described in this section include the following:

- ❖ *Nine pollutants failed screens for BOMA, with arsenic and naphthalene accounting for a majority of the failed screens.*

- ❖ *Among the pollutants of interest for BOMA, naphthalene had the highest annual average concentration for both 2015 and 2016.*

- *Some of the highest concentrations of arsenic, nickel, and cadmium across the program were measured at BOMA, including the maximum nickel concentration. For nickel and cadmium, these concentrations were the highest measured since the onset of sampling.*

- *Naphthalene concentrations have significantly decreased in magnitude at BOMA.*

- *Arsenic has the highest cancer risk approximations among the pollutants of interest for BOMA. None of the pollutants of interest for BOMA have noncancer hazard approximations greater than an HQ of 1.0.*

14.0 Site in Michigan

This section summarizes those data from samples collected at the NATTS site in Michigan and generated by ERG, EPA's contract laboratory for the NMP, over the 2015 and 2016 monitoring efforts. This section also examines the spatial and temporal characteristics of the ambient monitoring concentrations and reviews them through the context of risk. Readers are encouraged to refer to Sections 1 through 4 for detailed discussions and definitions regarding the various data analyses presented below.

> Data generated by sources other than ERG, EPA's contract laboratory for the NMP, are not included in the data analyses contained in this report.

14.1 Site Characterization

This section characterizes the Michigan monitoring site by providing a description of the nearby area surrounding the monitoring site; plotting emissions sources surrounding the monitoring site; and presenting traffic data and other characterizing information for the site. This information is provided to give the reader insight regarding factors that may influence the air quality near the site and assist in the interpretation of the ambient measurements.

The DEMI monitoring site is located in the Detroit-Warren-Dearborn, Michigan CBSA. Figure 14-1 presents the composite satellite image retrieved from ArcGIS Explorer showing the monitoring site and its immediate surroundings. Figure 14-2 identifies nearby point source emissions locations by source category, as reported in the 2014 NEI for point sources, version 1. Note that only sources within 10 miles of the site are included in the facility counts provided in Figure 14-2. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have a direct effect on the air quality at the monitoring site. Further, this boundary provides both the proximity of emissions sources to the monitoring site as well as the quantity of such sources within a given distance of the site. Sources outside the 10-mile boundary are still visible on the map for reference but have been grayed out to emphasize the emissions sources within the boundary. Table 14-1 provides supplemental geographical information such as land use, location setting, and locational coordinates. Each figure and table is discussed in detail in the paragraphs that follow.

Figure 14-1. Dearborn, Michigan (DEMI) Monitoring Site

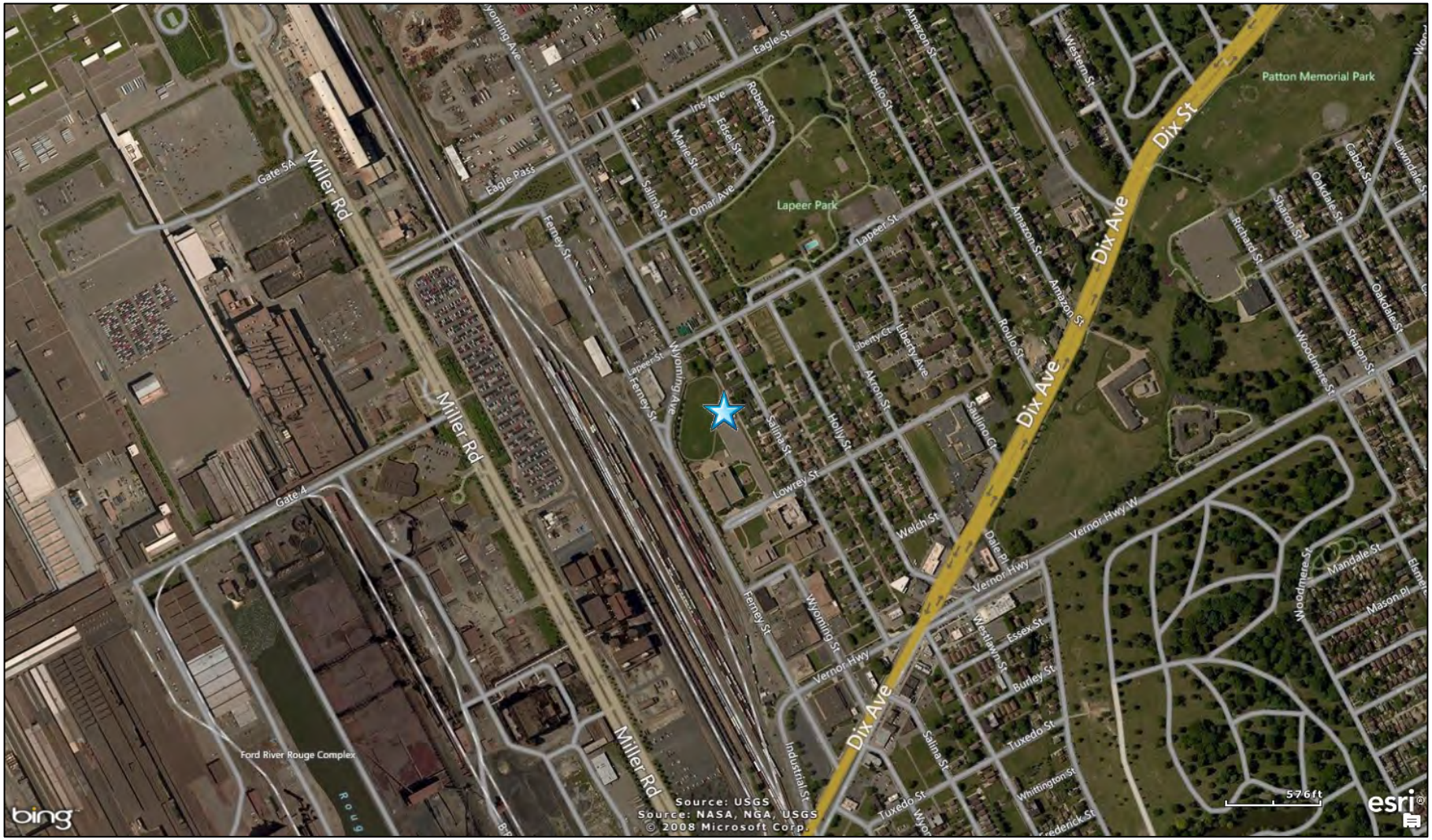


Figure 14-2. NEI Point Sources Located Within 10 Miles of DEMI

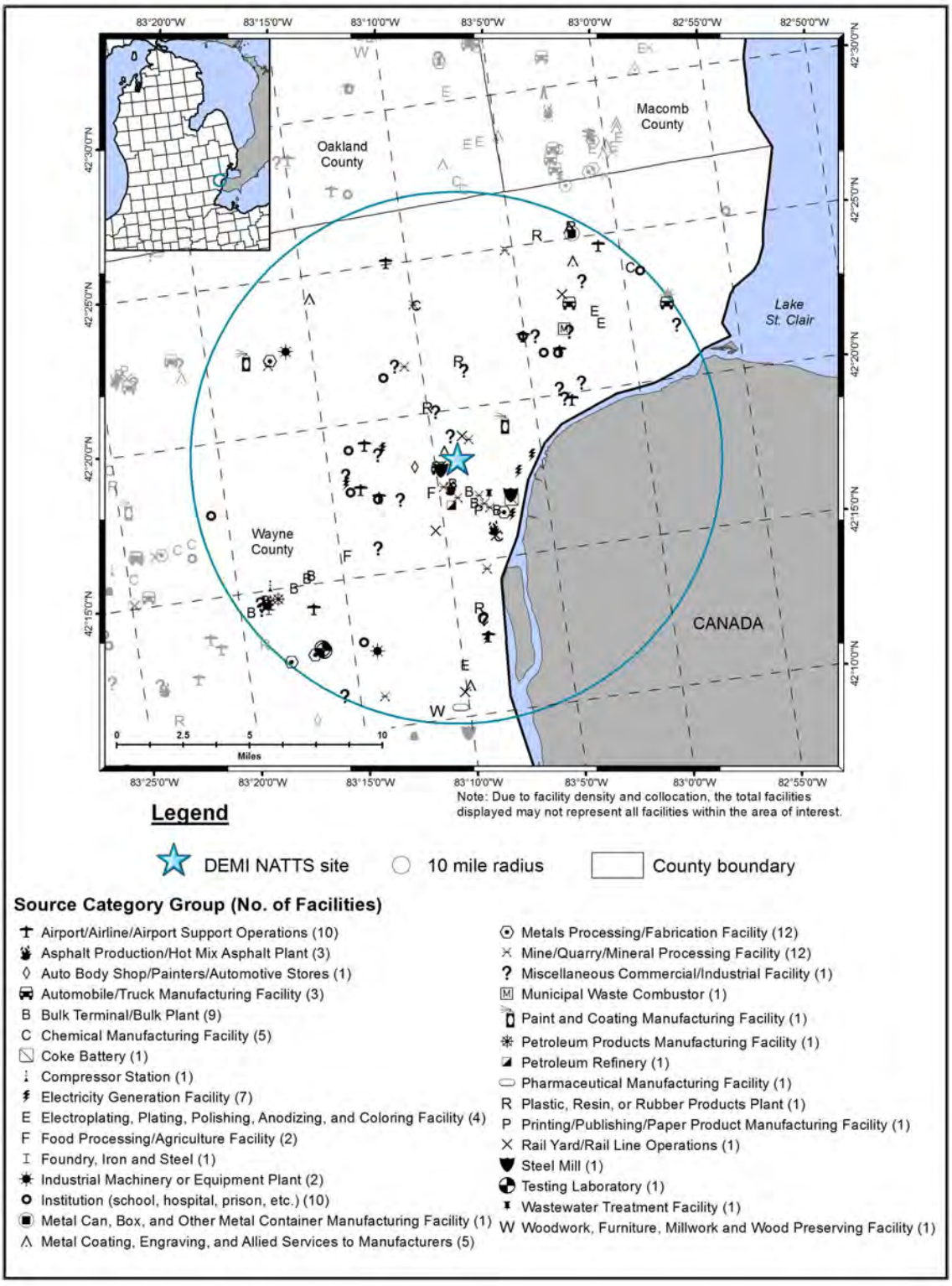


Table 14-1. Geographical Information for the Michigan Monitoring Site

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Annual Average Daily Traffic[1]	Intersection Used for Traffic Data
DEMI	26-163-0033	Dearborn	Wayne	Detroit-Warren-Dearborn, MI	42.306674, -83.148754	Industrial	Suburban	86,600	I-94 between Ford Plant and Rotunda Dr

[1]AADT reflects 2015 data (MI DOT, 2015)

BOLD ITALICS = EPA-designated NATTS Site

DEMI is located in the parking lot of Salina Elementary School in Dearborn, just southwest of Detroit, and is the Detroit NATTS site. The surrounding area is both suburban and industrial in nature. Figure 14-1 shows that a freight yard is located just west of the site and a residential neighborhood is located to the east. Industrial sources such as automobile and steel manufacturing facilities are also located in the vicinity. The monitoring site lies between two heavily traveled roadways, I-75 (1.4 miles to the east) and I-94 (1.2 miles to the west).

Figure 14-2 shows that DEMI is surrounded by numerous point sources. A cluster of sources is located just west of DEMI. Another cluster of sources is located farther south. The source categories with the most point sources within 10 miles of the site include the airport source category, which includes airports and related operations as well as small runways and heliports, such as those associated with hospitals or television stations; bulk terminals and bulk plants; mines, quarries, and mineral processing facilities; and institutional facilities (schools, prisons, and/or hospitals). Although difficult to discern in Figure 14-2, the closest sources to DEMI are just west of the site and include a steel mill and an automobile/truck manufacturing facility, part of which can be seen in the left-hand side of Figure 14-1, as well as a facility generating electricity via combustion, a metal coatings facility, and a rail yard. DEMI is located approximately 3 miles from the Canadian border; emission sources information is not provided for Canada.

In addition to providing city, county, CBSA, and land use/location setting information, Table 14-1 also contains traffic volume information for DEMI as well as the location for which the traffic volume was obtained. This information is provided because emissions from motor vehicles can significantly affect concentrations measured at a given monitoring site. The traffic volume near DEMI is 86,600 and ranks 13th highest among NMP sites. Traffic for DEMI is provided for I-94, between the Ford Plant and Rotunda Drive.

14.2 Pollutants of Interest

The risk-based screening process described in Section 3.2 was performed for each site to identify site-specific "pollutants of interest," which allows analysts and readers to focus on a subset of pollutants through the context of risk. Each pollutant's preprocessed daily measurement was compared to its associated risk screening value. If the concentration was greater than the risk screening value, then the concentration "failed the screen." The site-specific results of this risk-based screening process are presented in Table 14-2 and incorporate measurements from both 2015 and 2016. Pollutants of interest are those for which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens and are shaded in gray in Table 14-2. It is important to note which pollutants were sampled for at each site when reviewing the results of this analysis. VOCs, carbonyl compounds, and PAHs were sampled for at DEMI.

Table 14-2. 2015-2016 Risk-Based Screening Results for the Michigan Monitoring Site

Pollutant	Screening Value ($\mu g/m^3$)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Dearborn, Michigan - DEMI						
Naphthalene	0.029	122	123	99.19	12.72	12.72
Acetaldehyde	0.45	121	121	100.00	12.62	25.34
Formaldehyde	0.077	121	121	100.00	12.62	37.96
Benzene	0.13	120	120	100.00	12.51	50.47
Carbon Tetrachloride	0.17	120	120	100.00	12.51	62.98
1,3-Butadiene	0.03	119	119	100.00	12.41	75.39
1,2-Dichloroethane	0.038	111	112	99.11	11.57	86.97
Fluorene	0.011	36	113	31.86	3.75	90.72
Acenaphthene	0.011	35	115	30.43	3.65	94.37
Ethylbenzene	0.4	35	120	29.17	3.65	98.02
Fluoranthene	0.011	12	123	9.76	1.25	99.27
Benzo(a)pyrene	0.00057	2	122	1.64	0.21	99.48
p-Dichlorobenzene	0.091	2	28	7.14	0.21	99.69
Hexachloro-1,3-butadiene	0.045	1	2	50.00	0.10	99.79
Propionaldehyde	0.8	1	121	0.83	0.10	99.90
Xylenes	10	1	120	0.83	0.10	100.00
Total		959	1,700	56.41		

Observations from Table 14-2 for DEMI include the following:

- Concentrations of 16 pollutants failed at least one screen for DEMI; 56 percent of concentrations for these 16 pollutants were greater than their associated risk screening value (or failed screens).

- Ten pollutants contributed to 95 percent of failed screens for DEMI and therefore were identified as pollutants of interest for this site. These 10 include two carbonyl compounds, five VOCs, and three PAHs.

- Five pollutants listed in Table 14-2 failed 100 percent of screens (acetaldehyde, formaldehyde, benzene, carbon tetrachloride, and 1,3-butadiene), with two additional pollutants failing 99 percent of screens (naphthalene and 1,2-dichloroethane). Each of these pollutants contributed between 12 percent and 13 percent to the total number of failed screens; together these seven pollutants account for nearly 87 of the total failed screens.

For each of the data analyses described in the remaining sections, the focus is on the site-specific pollutants of interest identified via the risk-based screening process, as described in Section 3.4.2.

14.3 Concentrations

This section presents various concentration averages used to characterize air toxics concentration levels at the Michigan monitoring site. Where applicable, the following calculations and data analyses were performed for each of the site-specific pollutants of interest:

- Time period-based concentration averages (quarterly and annual) are provided for each monitoring site for each year.

- The range of measurements and annual average concentrations are presented graphically for each site to illustrate how the site's concentrations compare to the program-level averages, as presented in Section 4.1.

- Concentration averages and other statistical metrics for 2015, 2016, and from previous years of monitoring are presented in order to characterize concentration trends at each site.

Each data analysis is performed where the applicable criteria are met (as specified in the appropriate sections discussed below) and is limited to the site-specific pollutants of interest. However, site-specific statistical summaries for all pollutants sampled for at DEMI are provided in Appendices J, M, and N.

14.3.1 2015 and 2016 Concentration Averages

Quarterly and annual concentration averages for 2015 and 2016 were calculated for the pollutants of interest for the Michigan monitoring site, as described in Section 3.1. The *quarterly average concentration* of a particular pollutant is simply the average concentration of the preprocessed daily measurements over a given calendar quarter. Quarterly average concentrations include the substitution of zeros for all non-detects. A site must have a minimum of 75 percent valid samples compared to the total number of samples possible within a given calendar quarter for a quarterly average to be calculated. An *annual average concentration* includes all measured detections and substituted zeros for non-detects for an entire year of sampling. Annual averages were calculated for pollutants where three valid quarterly averages could be calculated for a given year and where method completeness was greater than or equal to 85 percent, as presented in Section 2.4. Quarterly and annual average concentrations for the pollutants of interest for the Michigan monitoring site are presented in Table 14-3, where applicable. Note that concentrations of the PAHs are presented in ng/m^3 for ease of viewing. Also note that if a pollutant was not detected in a given calendar quarter, the quarterly average simply reflects “0” because only zeros substituted for non-detects were factored into the quarterly average concentration.

Table 14-3. Quarterly and Annual Average Concentrations of the Pollutants of Interest for the Michigan Monitoring Site

Pollutant	2015						2016					
	# of Detects/ # >MDL/ # Samples	Q1 Avg (µg/m^3)	Q2 Avg (µg/m^3)	Q3 Avg (µg/m^3)	Q4 Avg (µg/m^3)	Annual Average (µg/m^3)	# of Detects/ # >MDL/ # Samples	Q1 Avg (µg/m^3)	Q2 Avg (µg/m^3)	Q3 Avg (µg/m^3)	Q4 Avg (µg/m^3)	Annual Average (µg/m^3)
Dearborn, Michigan – DEMI												
Acetaldehyde	60/60/60	1.74 ± 0.26	1.87 ± 0.27	2.02 ± 0.26	1.44 ± 0.32	1.77 ± 0.14	61/61/61	1.54 ± 0.15	2.53 ± 0.41	2.31 ± 0.26	1.48 ± 0.29	1.96 ± 0.18
Benzene	60/60/60	0.77 ± 0.12	0.71 ± 0.13	1.02 ± 0.20	0.69 ± 0.15	0.80 ± 0.08	60/60/60	0.65 ± 0.10	0.65 ± 0.19	0.79 ± 0.16	0.65 ± 0.19	0.68 ± 0.08
1,3-Butadiene	60/60/60	0.08 ± 0.01	0.10 ± 0.02	0.10 ± 0.03	0.09 ± 0.03	0.09 ± 0.01	59/44/60	0.08 ± 0.02	0.09 ± 0.04	0.08 ± 0.02	0.08 ± 0.03	0.08 ± 0.01
Carbon Tetrachloride	60/60/60	0.66 ± 0.05	0.67 ± 0.03	0.69 ± 0.04	0.65 ± 0.04	0.67 ± 0.02	60/60/60	0.65 ± 0.04	0.72 ± 0.04	0.62 ± 0.08	0.65 ± 0.03	0.66 ± 0.03
1,2-Dichloroethane	58/53/60	0.08 ± <0.01	0.08 ± 0.01	0.06 ± 0.01	0.06 ± 0.01	0.07 ± 0.01	54/48/60	0.07 ± 0.01	0.07 ± 0.01	0.04 ± 0.02	0.06 ± 0.01	0.06 ± 0.01
Ethylbenzene	60/59/60	0.18 ± 0.04	0.39 ± 0.11	0.66 ± 0.28	0.26 ± 0.07	0.37 ± 0.09	60/59/60	0.19 ± 0.06	0.28 ± 0.08	0.66 ± 0.40	0.33 ± 0.13	0.36 ± 0.11
Formaldehyde	60/60/60	2.75 ± 0.42	3.83 ± 0.53	4.25 ± 0.61	2.49 ± 0.52	3.33 ± 0.31	61/61/61	2.17 ± 0.37	4.24 ± 1.00	5.34 ± 0.82	2.51 ± 0.46	3.54 ± 0.47
Acenaphthene[a]	54/54/62	1.12 ± 0.74	12.16 ± 4.06	16.59 ± 4.30	6.55 ± 3.25	8.86 ± 2.14	61/61/61	3.77 ± 2.07	17.15 ± 9.10	16.80 ± 5.46	3.89 ± 1.90	10.30 ± 3.05
Fluorene[a]	59/59/62	2.17 ± 0.61	10.52 ± 2.73	15.46 ± 3.82	4.74 ± 1.53	7.93 ± 1.69	54/54/61	2.92 ± 1.62	15.13 ± 7.89	16.26 ± 4.68	4.41 ± 1.86	9.57 ± 2.69
Naphthalene[a]	62/62/62	69.79 ± 9.00	112.68 ± 13.75	166.07 ± 39.28	118.94 ± 33.71	116.18 ± 15.46	61/61/61	78.67 ± 19.91	120.67 ± 31.54	141.91 ± 30.98	88.67 ± 27.52	107.01 ± 14.51

[a] Average concentrations provided for the pollutants below the blue line are presented in ng/m^3 for ease of viewing.

Observations for DEMI from Table 14-3 include the following:

- The pollutants with the highest annual average concentrations are formaldehyde and acetaldehyde; all other annual average concentrations are less than 1.0 $\mu g/m^3$.

- Concentrations of formaldehyde measured at DEMI range from 0.981 $\mu g/m^3$ (which is the only one less than 1 $\mu g/m^3$) to 9.08 $\mu g/m^3$. The quarterly average concentrations for DEMI show that formaldehyde concentrations tended to be higher during the warmer months of the year. All but one of the 18 formaldehyde concentrations greater than 5 $\mu g/m^3$ were measured at DEMI between April and September of either year. Conversely, only two of the 20 formaldehyde concentrations less than 2 $\mu g/m^3$ were measured during the first or fourth quarters of the year (with the two exceptions measured in April).

- Concentrations of acetaldehyde measured at DEMI range from 0.760 $\mu g/m^3$ to 4.78 $\mu g/m^3$. Concentrations of acetaldehyde exhibit a similar pattern in seasonal tendency as formaldehyde, although the difference is less pronounced, particularly for 2015 compared to 2016.

- Benzene has the highest annual average concentrations among the VOC pollutants of interest for DEMI. Concentrations of benzene measured at DEMI range from 0.211 $\mu g/m^3$ to 1.95 $\mu g/m^3$. Most of the quarterly average concentrations of benzene fall within a relatively small range, with the exception of the third quarter average concentration for 2015 (1.02 ± 0.20 $\mu g/m^3$). A review of the data shows that the maximum concentration of benzene was measured during this calendar quarter. Further, seven benzene concentrations greater than 1 $\mu g/m^3$ were measured during this quarter, with three or less measured during each of the other calendar quarters.

- Both third quarter average concentrations of ethylbenzene are approximately twice the other quarterly averages and have the largest confidence intervals associated with them. A similar observation was made in the 2014 NMP report. Concentrations of ethylbenzene measured at DEMI span two orders of magnitude, ranging from 0.0348 $\mu g/m^3$ to 3.07 $\mu g/m^3$, which is the maximum ethylbenzene concentration measured across the program. The second highest ethylbenzene concentration measured at DEMI (2.16 $\mu g/m^3$) is the third highest measured across the program. Both of these concentrations were measured in August, but in different years. The five highest ethylbenzene concentrations were measured at DEMI in July, August, or September (three in 2015, two in 2016). In 2015, 11 ethylbenzene concentrations greater than or equal to 0.5 $\mu g/m^3$ were measured, with more than half (7) measured during the third quarter. In 2016, 13 ethylbenzene concentrations greater than or equal to 0.5 $\mu g/m^3$ were measured, with nearly half (6) measured during the third quarter (with five measured on back-to-back sample days in late August and September). Five more concentrations of this magnitude were measured during November of 2016.

- The remaining VOCs exhibit relatively little variability in their quarterly and annual average concentrations.

- Based on the quarterly average concentrations shown, concentrations of naphthalene were significantly lower during the first quarter of 2015. This is also true for 2016, although to a lesser extent. Concentrations of naphthalene measured at DEMI range from to 19.4 ng/m^3 to 312 ng/m^3. All but three of the 30 naphthalene concentrations less than 70 ng/m^3 were measured during the first or fourth quarters of either year. For 2015, all 11 were measured during these calendar quarters, seven during the first and four during the fourth. For 2016, there was 19 of these, nine measured during the first quarter, seven during the fourth, with the three exceptions measured in April. Only one naphthalene concentration greater than 100 ng/m^3 was measured at DEMI during the first quarter of 2015; the number measured ranged from nine to 11 for the remaining calendar quarters. For 2016, seven naphthalene concentrations greater than 100 ng/m^3 were measured during the first (four) and fourth (three) quarters, while 23 were measured during the second (10) and third (13) quarters.

- Concentrations of fluorene were higher during the warmer months of both sampling years, as indicated by the quarterly average concentrations. Concentrations of fluorene measured at DEMI range from 0.770 ng/m^3 to 43.8 ng/m^3, and include 10 non-detects. Of the 25 fluorene concentrations greater than or equal to 15 ng/m^3 measured at DEMI, only one was measured outside the second or third calendar quarters. Conversely, all but two of the 37 fluorene concentrations less than 4 ng/m^3 were measured during the first or fourth quarters of either year. Further, nine of the 10 non-detects were measured during the first or fourth calendar quarters; two were measured during the first quarter of 2015, with the remainder measured between late December 2015 and mid-April 2016.

- Quarterly average concentrations of acenaphthene exhibit a similar seasonal tendency, although these quarterly average concentrations have even larger confidence intervals associated with them. Concentrations of acenaphthene measured at DEMI range from 0.673 ng/m^3 to 50.0 ng/m^3, and include eight non-detects. Note the relatively low quarterly average concentration for the first quarter of 2015; all eight non-detects were measured between January and March 2015, with seven on back-to-back sample days.

Tables 4-10 through 4-13 present the NMP sites with the 10 highest annual average concentrations for each of the program-level pollutants of interest. Observations for DEMI from those tables include the following:

- DEMI appears in Table 4-10 for VOCs twice. This site has the ninth and tenth highest annual average concentrations of carbon tetrachloride among NMP sites sampling this pollutant; however, with few exceptions, the difference among the annual average concentrations of this pollutant vary little across the sites.

- DEMI does not appear in Table 4-11 for its annual average concentrations of the carbonyl compounds.

- DEMI has the highest (2015) and third highest (2016) annual average concentrations of naphthalene among NMP sites sampling PAHs, as shown in Table 4-12. DEMI is one of only two sites with an annual average concentration of naphthalene greater

than 100 ng/m^3. DEMI's annual average concentrations of acenaphthene and fluorene both rank fifth (2016) and sixth (2015) among NMP sites sampling PAHs.

14.3.2 Concentration Comparison

In order to better illustrate how each site's annual average concentrations compare to the program-level averages, a site-specific box plot was created for each of the site-specific pollutants of interest, where applicable. Thus, box plots were created for each of the pollutants listed in Table 14-3. Figures 14-3 through 14-12 overlay the Michigan site's minimum, annual average, and maximum concentrations for each year onto the program-level minimum, first quartile, median, average, third quartile, and maximum concentrations, as described in Section 3.4.2.1, and are discussed below. If an annual average concentration could not be calculated, the range of concentrations is still provided in the figures that follow.

Figure 14-3. Program vs. Site-Specific Average Acenaphthene Concentrations

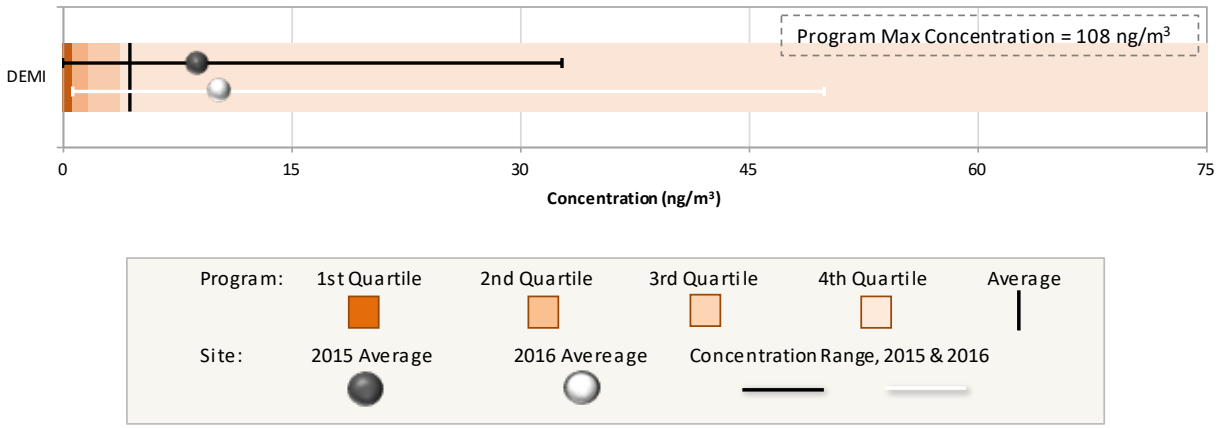


Figure 14-3 presents the box plot for acenaphthene for DEMI and shows the following:

- The program-level maximum concentration (108 ng/m^3) of acenaphthene is not shown directly on the box plot because the scale of the box plot would be too large to readily observe data points at the lower end of the concentration range. Thus, the scale has been reduced.
- The maximum acenaphthene concentration measured at DEMI (50 ng/m^3) is roughly half the magnitude of the maximum concentration measured across the program.
- The range of concentrations measured in 2016 at DEMI is larger than the range of concentrations measured in 2015.
- All eight non-detects of acenaphthene were measured at DEMI in 2015.
- Although the annual average for 2016 is slightly higher than the annual average for 2015, both are more than twice the program-level average concentration (4.36 ng/m^3).

Figure 14-4. Program vs. Site-Specific Average Acetaldehyde Concentrations

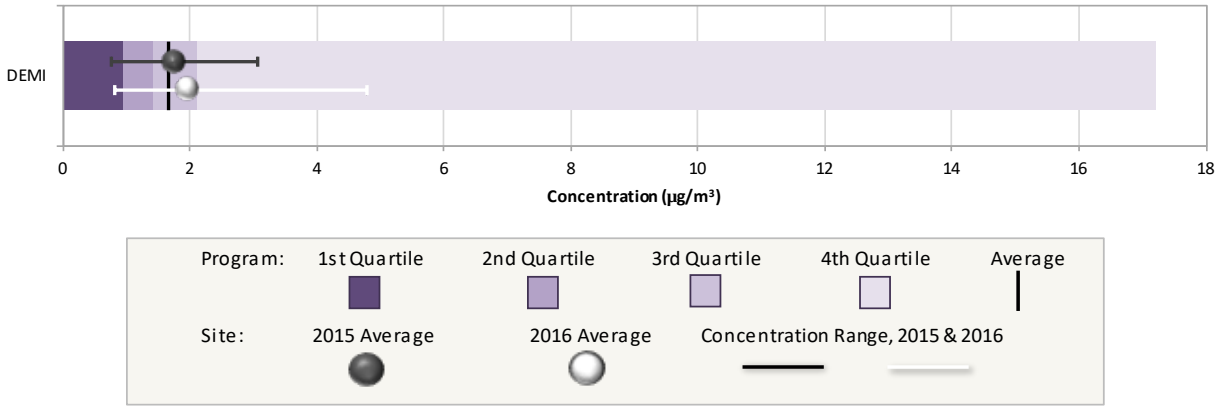


Figure 14-4 presents the box plot for acetaldehyde for DEMI and shows the following:

- The range of acetaldehyde concentrations measured at DEMI in 2015 is smaller than the range measured in 2016, although both are relatively small compared to the range of concentrations measured across the program.

- Both of DEMI's annual average concentrations of acetaldehyde fall between the program-level average concentration and the program-level third quartile.

Figure 14-5. Program vs. Site-Specific Average Benzene Concentrations

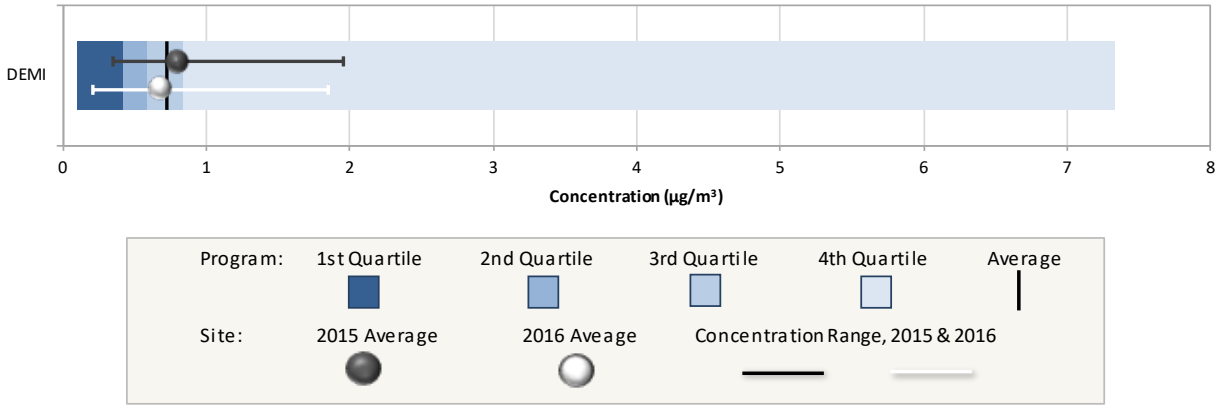


Figure 14-5 presents the box plot for benzene for DEMI and shows the following:

- All benzene concentrations measured at DEMI in 2015 and 2016 are less than 2 µg/m^3.

- The annual average benzene concentrations for this site fall on either side of the program-level average concentration (0.72 µg/m^3).

Figure 14-6. Program vs. Site-Specific Average 1,3-Butadiene Concentrations

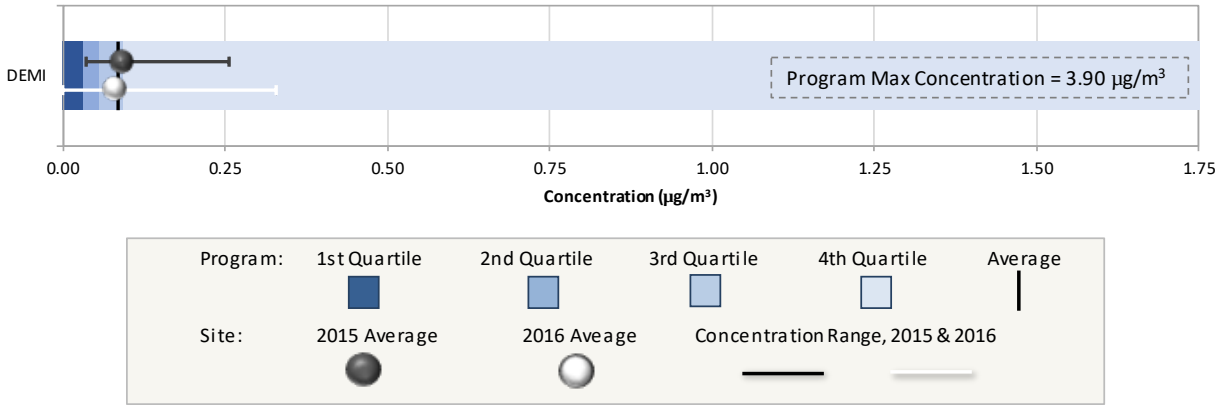


Figure 14-6 presents the box plot for 1,3-butadiene for DEMI and shows the following:

- The program-level maximum 1,3-butadiene concentration (3.90 µg/m^3) is not shown directly on the box plot in Figure 14-6 because the scale of the box plot would be too large to readily observe data points at the lower end of the concentration range. Thus, the scale of the box plot has been reduced.

- The range of 1,3-butadiene concentrations measured at DEMI in 2015 is smaller than the range measured in 2016, although both are relatively small compared to the range of concentrations measured across the program. At the low end of the concentration range, the difference between the two years is a result of the single non-detect measured in 2016. Excluding this measurement, the minimum concentration for each year would be similar.

- The annual average concentrations for DEMI are similar to each other, differing by only 0.01 µg/m^3. These annual averages are is similar to the program-level average concentration.

Figure 14-7. Program vs. Site-Specific Average Carbon Tetrachloride Concentrations

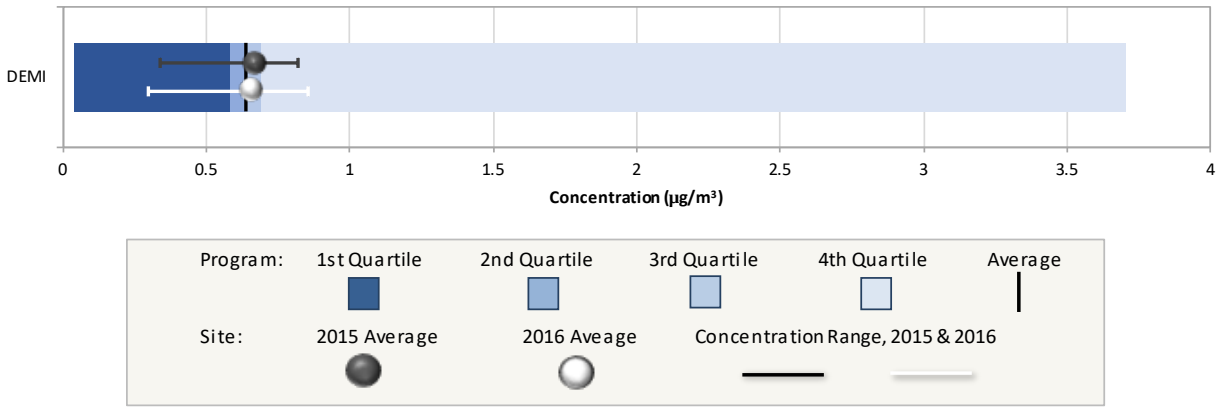


Figure 14-7 presents the box plot for carbon tetrachloride for DEMI and shows the following:

- The range of carbon tetrachloride concentrations measured at DEMI is considerably smaller than the range measured across the program, though fairly similar to the range measured at the majority of NMP sites during the 2015 and 2016 monitoring efforts.

- DEMI's annual average concentration of carbon tetrachloride for 2015 is similar to annual average concentration for 2016; both annual averages fall between the program-level average concentration (0.64 µg/m^3) and the program-level third quartile (0.69 µg/m^3).

Figure 14-8. Program vs. Site-Specific Average 1,2-Dichloroethane Concentrations

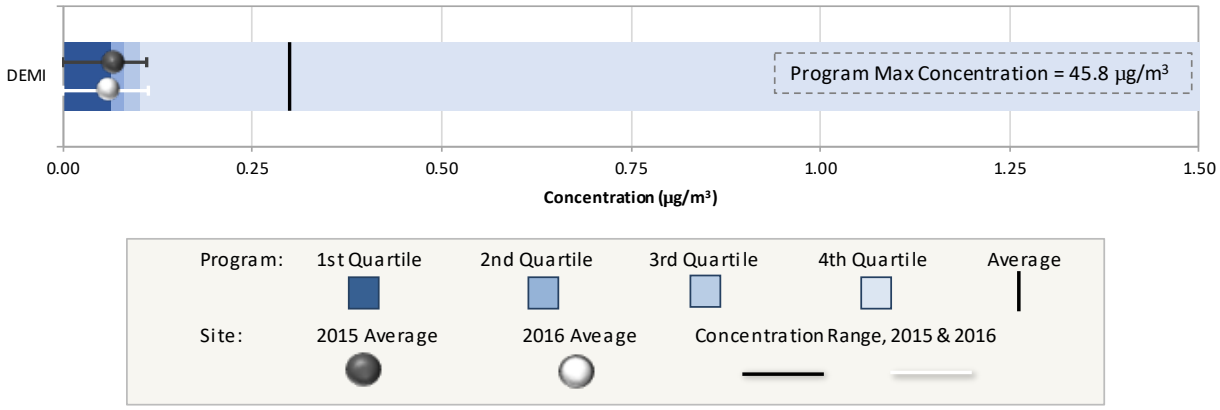


Figure 14-8 presents the box plot for 1,2-dichloroethane for DEMI and shows the following:

- The scale of the box plot in Figure 14-8 has also been reduced to allow for the observation of data points at the lower end of the concentration range, as the program-level maximum 1,2-dichloroethane concentration (45.8 µg/m^3) is considerably greater than the majority of measurements. Note that the program-level average is being driven by the measurements at the upper end of the concentration range, as this average is nearly three times greater than the program-level third quartile.

- The range of 1,2-dichloroethane concentrations measured at DEMI in 2015 is similar to the range measured in 2016, with all measurements less than 0.12 µg/m^3, and only three concentrations greater than the program-level third quartile.

- Both annual average concentrations of 1,2-dichloroethane for DEMI are less than the program-level median concentration, with the annual average for 2016 also less than the program-level first quartile.

Figure 14-9. Program vs. Site-Specific Average Ethylbenzene Concentrations

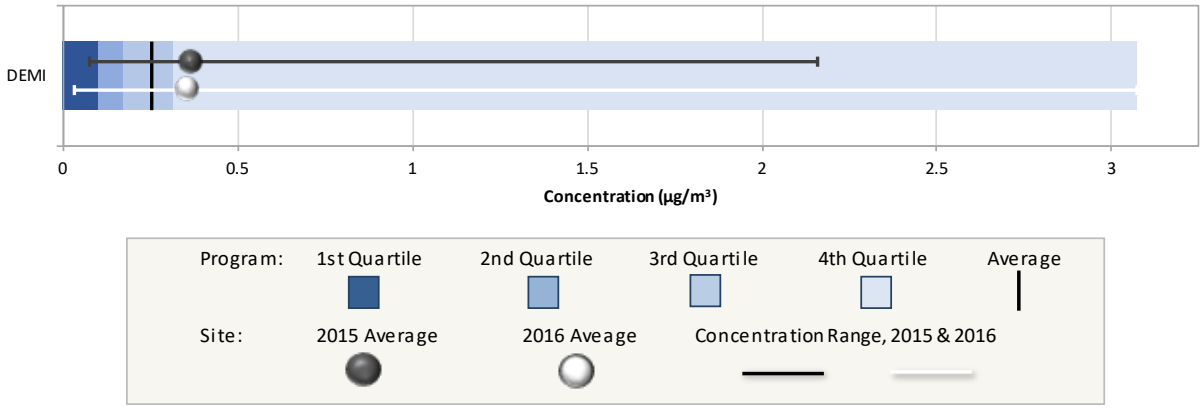


Figure 14-9 presents the box plot for ethylbenzene for DEMI and shows the following:

- The maximum ethylbenzene concentration measured at DEMI in 2016 is the maximum concentration measured across the program. While the maximum ethylbenzene concentration measured at DEMI in 2015 is les, it is still the third highest ethylbenzene concentration measured across the program.

- The annual average concentrations of ethylbenzene for DEMI are similar to each other and both are greater than both the program-level average and third quartile.

Figure 14-10. Program vs. Site-Specific Average Fluorene Concentrations

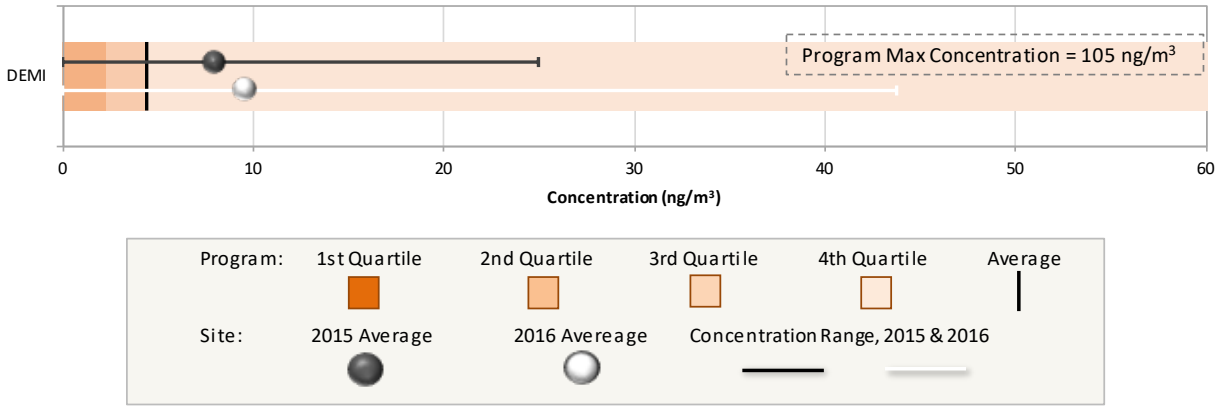


Figure 14-10 presents the box plot for fluorene for DEMI and shows the following:

- The scale of the box plot has also been reduced to allow for the observation of data points at the lower end of the concentration range. Note that the program-level first quartile of fluorene is zero and therefore not visible on the box plot.

- The maximum fluorene concentration measured at DEMI is considerably less than the maximum concentration measured across the program. The range of concentrations measured at DEMI in 2016 is larger than the range of concentrations measured in 2015, with the six highest fluorene concentrations measured at DEMI in 2016.

- Both annual average concentrations of fluorene for DEMI are greater than the program-level average concentration (4.36 ng/m^3) and third quartile; the annual average for 2016 is more than the twice the program-level average concentration and ranks fifth highest among NMP sites sampling this pollutant (the annual average for 2015 ranks sixth highest).

Figure 14-11. Program vs. Site-Specific Average Formaldehyde Concentrations

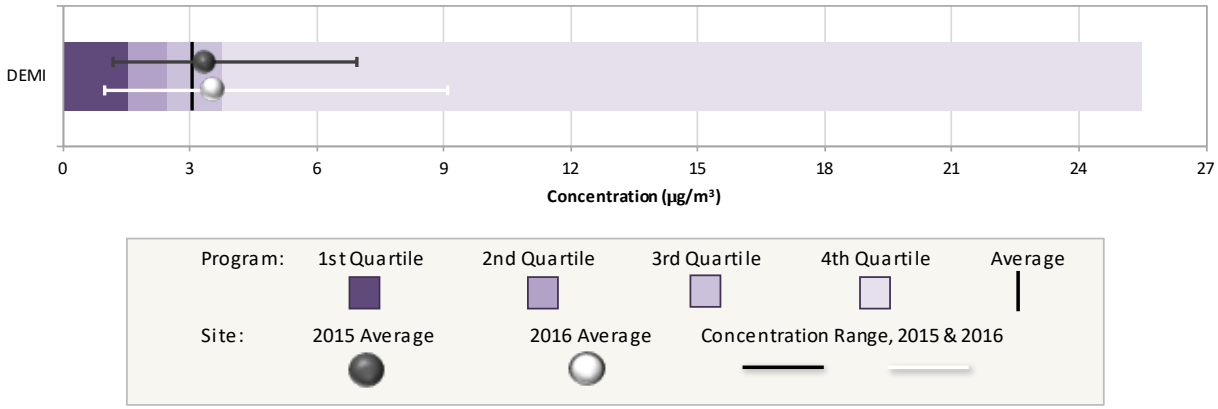


Figure 14-11 presents the box plot for formaldehyde for DEMI and shows the following:

- The range of formaldehyde concentrations measured at DEMI in 2015 is smaller than the range measured in 2016, although both are relatively small compared to the range of concentrations measured across the program.

- Both of DEMI's annual average concentrations of formaldehyde fall between the program-level average concentration and the program-level third quartile.

Figure 14-12. Program vs. Site-Specific Average Naphthalene Concentrations

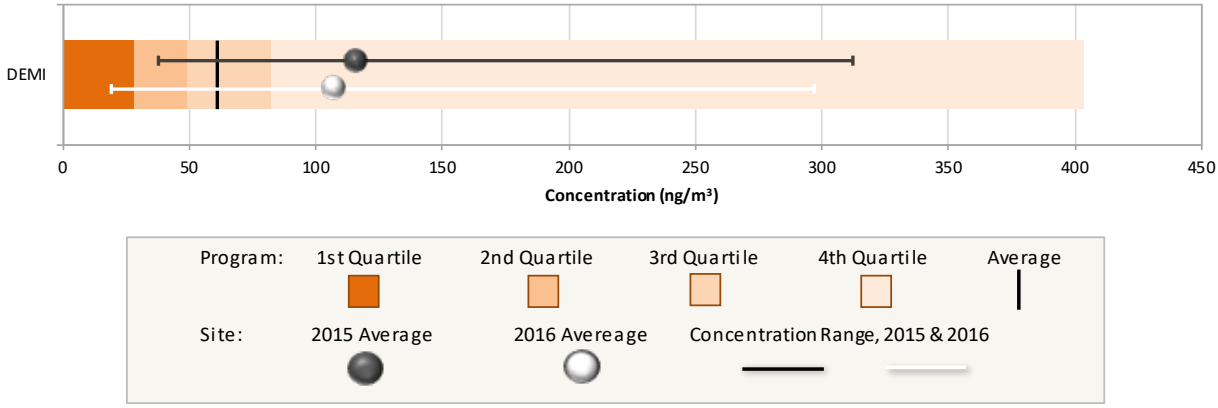


Figure 14-12 presents the box plot for naphthalene for DEMI and shows the following:

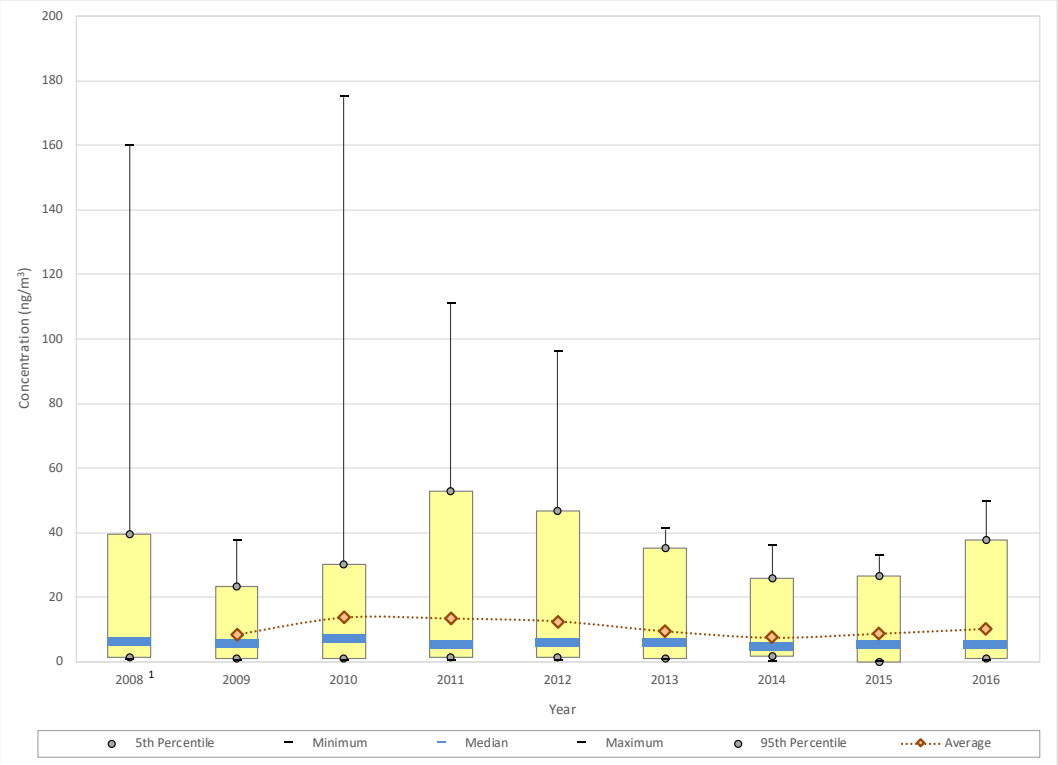
- DEMI is one of only three NMP sites at which naphthalene concentrations greater than 300 ng/m^3 were measured.

- Both annual average concentrations of naphthalene for DEMI are greater than 100 ng/m^3; DEMI is the only site for which this is true. DEMI has the highest and third highest annual averages of naphthalene across the program. DEMI's annual average concentration for 2015 is just less than twice the program-level average concentration (61.23 ng/m^3).

14.3.3 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the pollutants of interest for 5 consecutive years or longer, as described in Section 3.4.2.2. DEMI has sampled VOCs and carbonyl compounds under the NMP since 2003 and PAHs since 2008. Thus, Figures 14-13 through 14-22 present the 1-year statistical metrics for each of the pollutants of interest for DEMI. The statistical metrics presented for assessing trends include the substitution of zeros for non-detects. If sampling began mid-year, a minimum of 6 months of sampling is required for inclusion in the trends analysis; in these cases, a 1-year average concentration is not provided, although the range and percentiles are still presented.

Figure 14-13. Yearly Statistical Metrics for Acenaphthene Concentrations Measured at DEMI



[1] A 1-year average is not presented because sampling under the NMP did not begin until April 2008.

Observations from Figure 14-13 for acenaphthene concentrations measured at DEMI include the following:

- DEMI began sampling PAHs under the NMP in April 2008. Because a full year's worth of data is not available for 2008, a 1-year average concentration is not presented, although the range of measurements is provided.

- The maximum acenaphthene concentration (175 ng/m^3) was measured at DEMI on August 18, 2010. Four additional measurements greater than 100 ng/m^3 have been measured at DEMI (two in 2008, another in 2010, and one in 2011).

- Higher concentrations of acenaphthene tended to be measured during the warmer months of the year. Of the 38 acenaphthene concentrations greater than 30 ng/m^3, 32 were measured in June, July, or August of a given year, with all of these concentrations measured at DEMI between May and September.

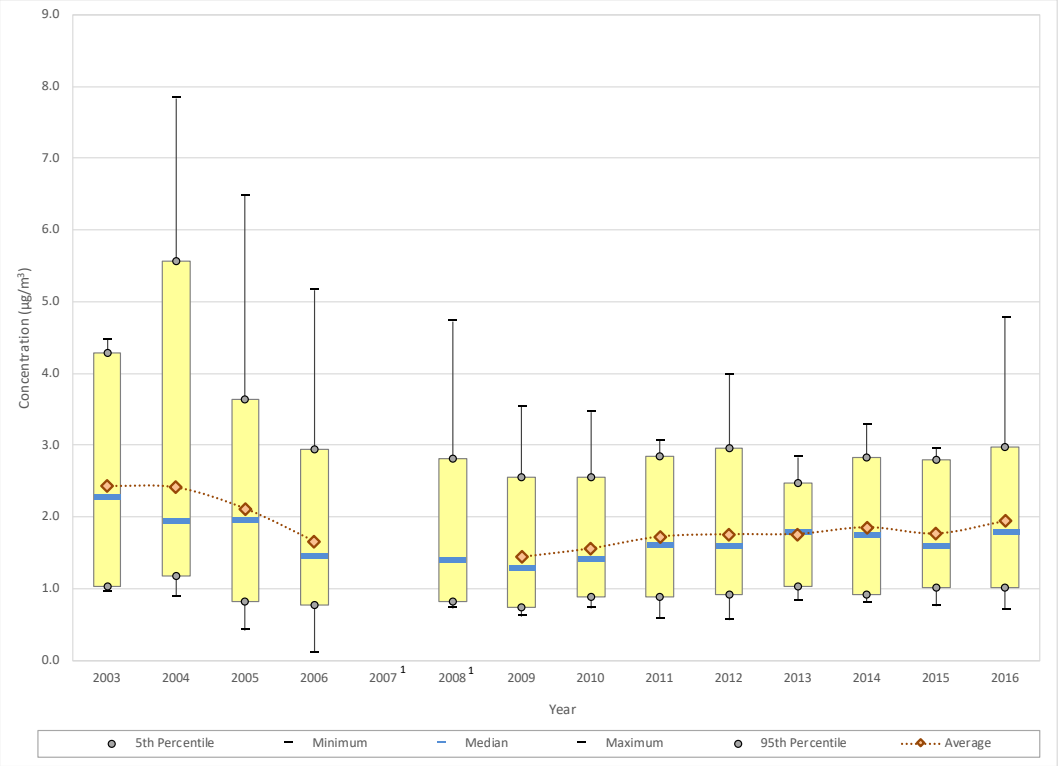
- Although most of the statistical metrics increased (at least slightly) from 2009 to 2010, the 1-year average concentration is being driven by the two highest concentrations measured in 2010 (both greater than 100 ng/m^3). The next highest concentration measured in 2010 is considerably less (55.1 ng/m^3). If the two highest concentrations were excluded from the calculation, the 1-year average concentration for 2010 would decrease from 13.73 ng/m^3 to 9.01 ng/m^3, which is similar to the 1-year average concentration for 2009.

- The 95th percentile increased steadily between 2009 and 2011, indicating that concentrations of "higher" magnitude accounted for an increasing number of measurements. The number of concentrations greater than 25 ng/m^3 increased from three to four to 10 during this period.

- The maximum, 95th percentile, and 1-year average concentration of acenaphthene exhibit decreases between 2011 and 2014. Both the 1-year average and median concentrations are at a minimum for 2014 and the first non-detect was measured in 2014. The 1-year average concentrations have decreased from 13.44 ng/m^3 (2011) to 7.66 ng/m^3 (2014) during this time. But with relatively large confidence intervals associated with the 1-year average concentrations, these changes shown are not statistically significant.

- Most of the changes shown in the years that follow are related to the statistical parameters representing the concentrations on the upper end of the concentration range. The minimum and 5th percentile for 2015 are both zero, as the number of non-detects increased to eight. Non-detects were not measured during any other years of sampling.

Figure 14-14. Yearly Statistical Metrics for Acetaldehyde Concentrations Measured at DEMI



[1] A 1-year average is not presented because data from March 2007 to March 2008 were invalidated.

Observations from Figure 14-14 for acetaldehyde concentrations measured at DEMI include the following:

- Carbonyl compounds have been sampled continuously at DEMI under the NMP since 2003, beginning with a 1-in-12 day schedule in 2003 then changing to a 1-in-6 day schedule in the spring of 2004.

- Carbonyl compound samples collected on the primary collection system between March 13, 2007 and March 25, 2008 were invalidated by the state of Michigan due to a leak in the sample line. With only 12 valid samples in 2007, no statistical metrics are provided. Because less than 75 percent of the samples were valid in 2008, a 1-year average is not presented for 2008, although the range of measurements is provided.

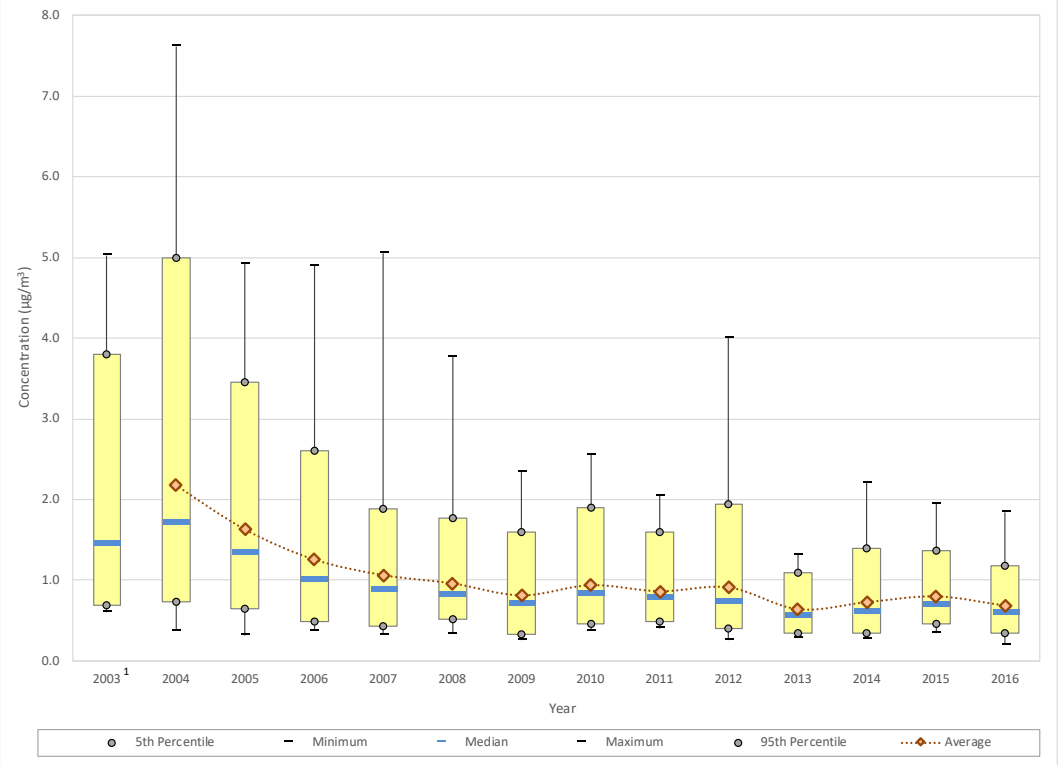
- The maximum acetaldehyde concentration was measured at DEMI in 2004 (7.84 µg/m^3). In total, six concentrations greater than 5 µg/m^3 have been measured at DEMI, three in 2004, two in 2005, and one in 2006 (and none in the years that follow).

- The 1-year average concentration exhibits a decreasing trend after 2004 that continues through 2006. A 1-year average concentration is not available for 2007 or 2008, although the median concentration, which is available for 2008, changed little from 2006 to 2008, then decreased slightly for 2009. Both the 1-year average and

median concentrations are at a minimum for 2009 (1.44 µg/m^3 and 1.30 µg/m^3, respectively).

- The 1-year average concentration has a nearly continuous increasing trend after 2009 through 2014; a slight decrease is shown for 2015, which is followed by an additional increase for 2016. The 1-year average concentration for 2016 is at its highest since 2005. The median concentration does not follow this exact pattern but is also at its highest since 2005.

Figure 14-15. Yearly Statistical Metrics for Benzene Concentrations Measured at DEMI



[1] A 1-year average is not presented due to low completeness for 2003.

Observations from Figure 14-15 for benzene concentrations measured at DEMI include the following:

- VOCs have been sampled continuously at DEMI under the NMP since 2003. However, the 1-in-12 day schedule combined with a number of invalid samples resulted in low completeness in 2003; as a result, a 1-year average concentration is not presented for 2003.

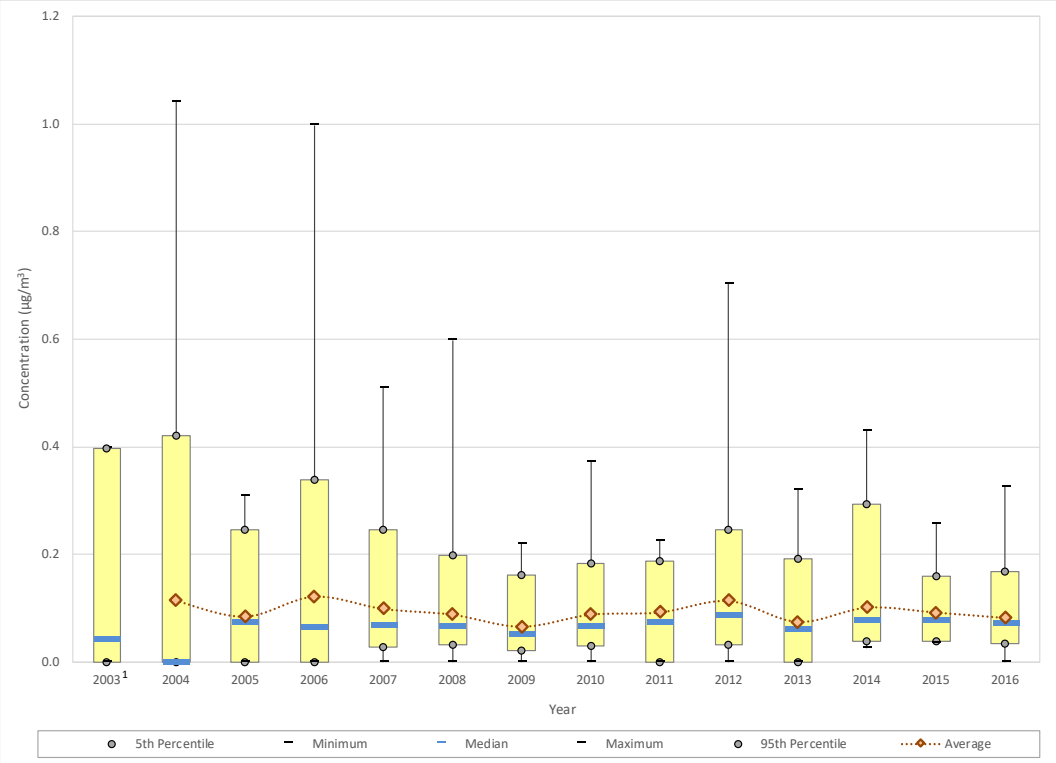
- The three highest benzene concentrations were measured at DEMI in 2004 and range from 5.44 µg/m^3 to 7.62 µg/m^3. Two other concentrations greater than 5 µg/m^3 have been measured at DEMI, one in 2003 and one in 2007.

- Both the 1-year average and median concentrations exhibit a steady decreasing trend between 2004 and 2009. Between 2009 and 2012, the 1-year average concentration has an undulating pattern and fluctuated between 0.81 µg/m^3 (2009) and 0.94 µg/m^3 (2010).

- A significant decrease in benzene concentrations is shown for 2013, as the smallest range of benzene concentrations was measured at DEMI in 2013 and all of the statistical metrics decreased except the minimum concentration. Both the 1-year average (0.64 µg/m^3) and median (0.59 µg/m^3) concentrations are at a minimum for 2013.

- A slight increasing trend in benzene concentrations is shown between 2013 and 2015, before decreasing again for 2016. However, the central tendency parameters calculated for each of these years are still less than those calculated for the years 2012 and prior.

Figure 14-16. Yearly Statistical Metrics for 1,3-Butadiene Concentrations Measured at DEMI



[1] A 1-year average is not presented due to low completeness for 2003.

Observations from Figure 14-16 for 1,3-butadiene concentrations measured at DEMI include the following:

- The maximum 1,3-butadiene concentration (1.04 µg/m^3) was measured on October 18, 2004 and is the only 1,3-butadiene concentration greater than 1 µg/m^3 measured at DEMI, although additional concentrations greater than 0.90 µg/m^3 were measured in 2004 and 2006.

- For 2004, the minimum, 5th percentile, and median concentrations are all zero, indicating that at least half of the measurements were non-detects. Yet, two of the three highest concentrations were also measured at DEMI in 2004; in addition, the 95th percentile is at a maximum for 2004. This indicates there is a high level of variability within these measurements.

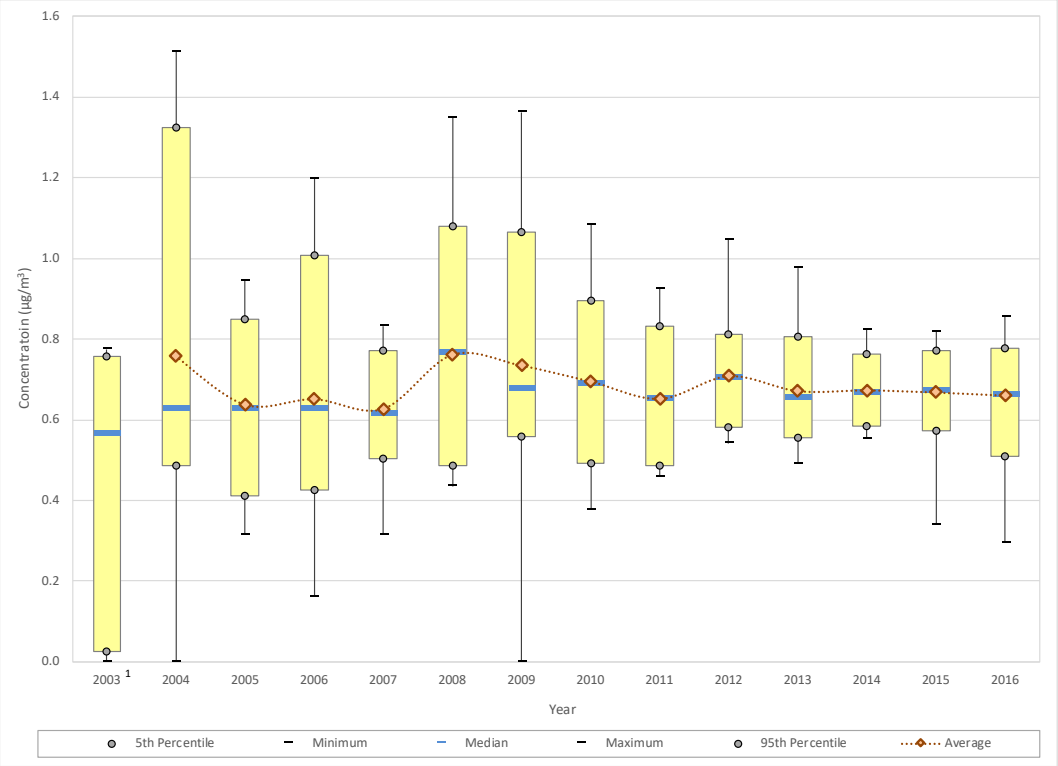
- Fewer non-detects were measured in 2005 and 2006, as indicated by the increase in the median concentration, and even fewer in most of the years that follow, as indicated by the increase in the 5th percentile. The percentage of non-detects decreased from a high of 60 percent in 2004 to 2 percent in 2008, then fluctuated between 2 percent and 8 percent for the years that follow until 2014, when non-detects were not measured. Non-detects were not measured in 2015 either, and a single non-detect was measured in 2016.

- Even as the number of non-detects decreased (and thus, the number of zeros factored into the calculation decreased), the 1-year average concentration decreased by almost half between 2006 and 2009. This was followed by an increasing trend between 2009 and 2012, returning the 1-year average concentration to near 2006 levels.

- The 1-year average concentration decreased significantly from 2012 to 2013, as did the median, both of which are at their lowest since 2009. The number of 1,3-butadiene concentrations greater than 0.1 $\mu g/m^3$ decreased considerably between the two years, from 27 measured in 2012 to 10 in 2013.

- All of the statistical metrics exhibit increases for 2014. Although decreases in the 1-year average concentration are shown between 2014 and 2016, confidence intervals calculated indicate that the changes exhibited over the last several years of sampling are not statistically significant.

Figure 14-17. Yearly Statistical Metrics for Carbon Tetrachloride Concentrations Measured at DEMI



[1] A 1-year average is not presented due to low completeness for 2003.

Observations from Figure 14-17 for carbon tetrachloride concentrations measured at DEMI include the following:

- In 2003, measured detections ranged from 0.25 µg/m^3 to 0.76 µg/m^3, plus two non-detects. This is the only year of sampling for which nearly half the measurements were less than 0.6 µg/m^3.

- The range of concentrations measured in 2004 doubled from 2003 levels. The number of measurements greater than 1 µg/m^3 increased from none in 2003 to 12 for 2004.

- The 1-year average concentration decreased by more than 0.1 µg/m^3 from 2004 to 2005, as the range of concentrations measured decreased substantially. Little change in the 1-year average concentration is shown from 2005 to 2007, despite the differences in the ranges of concentrations measured.

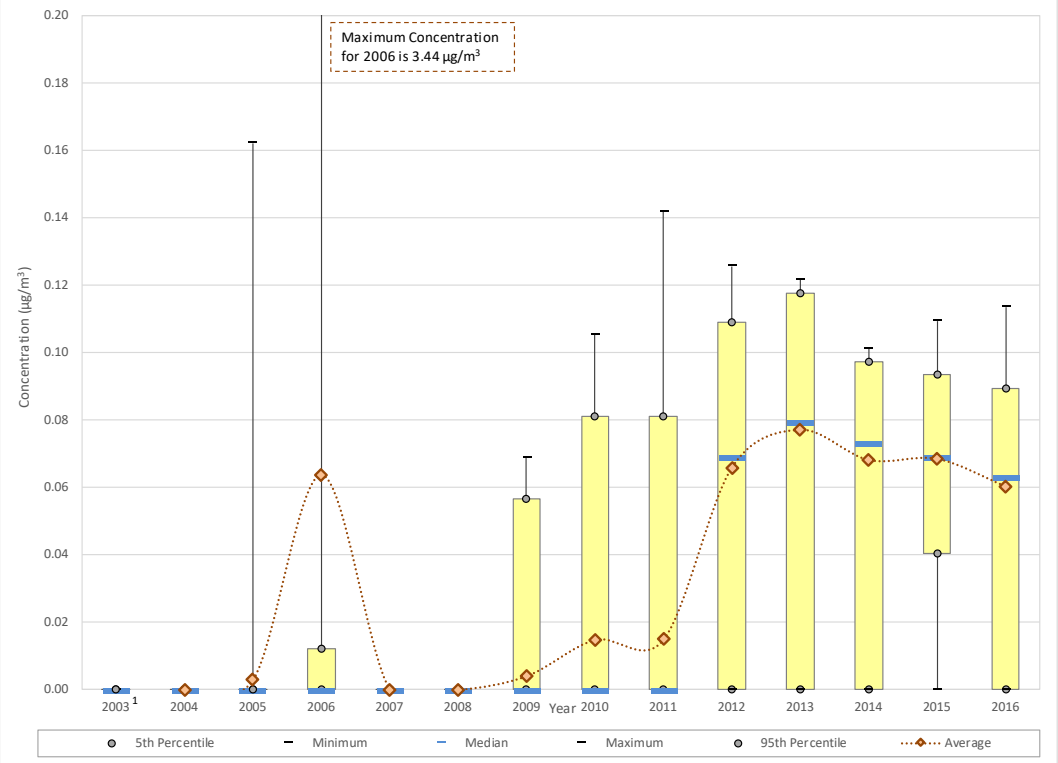
- With the exception of the 5th percentile, all of the statistical metrics increased for 2008, with the 1-year average and median concentrations for 2008 similar to the 95th percentile for 2007.

- A steady decreasing trend in the 1-year average concentration is shown between 2008 and 2011. Between these years, the majority of concentrations fell within a tighter concentration range, as indicated by the difference between the 5th and 95th percentiles.

- The difference between the 5th and 95th percentiles for 2012 is less than 0.25 µg/m^3, which is the smallest difference up to this point, yet an increase in the 1-year average and median concentrations is shown for 2012. The number of carbon tetrachloride concentrations falling between 0.7 µg/m^3 and 0.9 µg/m^3 more than doubled from 2011 (13) to 2012 (32), accounting for more than half of the measurements for 2012. All of the statistical parameters exhibit a slight decrease from 2012 to 2013, as the number of carbon tetrachloride concentrations falling between 0.7 µg/m^3 and 0.9 µg/m^3 decreased by half (16).

- The smallest range of carbon tetrachloride concentrations was measured in 2014, spanning just over 0.25 µg/m^3. In addition, the majority of concentrations measured in 2014 fall into the tightest range of concentrations measured, as indicated by the difference between the 5th and 95th percentiles. Despite this tightening of measurements, little change is shown in the central tendency statistics for 2014. In fact, the central tendency parameters changed little over the last four years of sampling.

Figure 14-18. Yearly Statistical Metrics for 1,2-Dichloroethane Concentrations Measured at DEMI



[1] A 1-year average is not presented due to low completeness for 2003.

Observations from Figure 14-18 for 1,2-dichloroethane concentrations measured at DEMI include the following:

- There were no measured detections of 1,2-dichloroethane in 2003, 2004, 2007, or 2008. Through 2011, the median concentration is zero for all years, indicating that at least half of the measurements are non-detects: there was only one measured

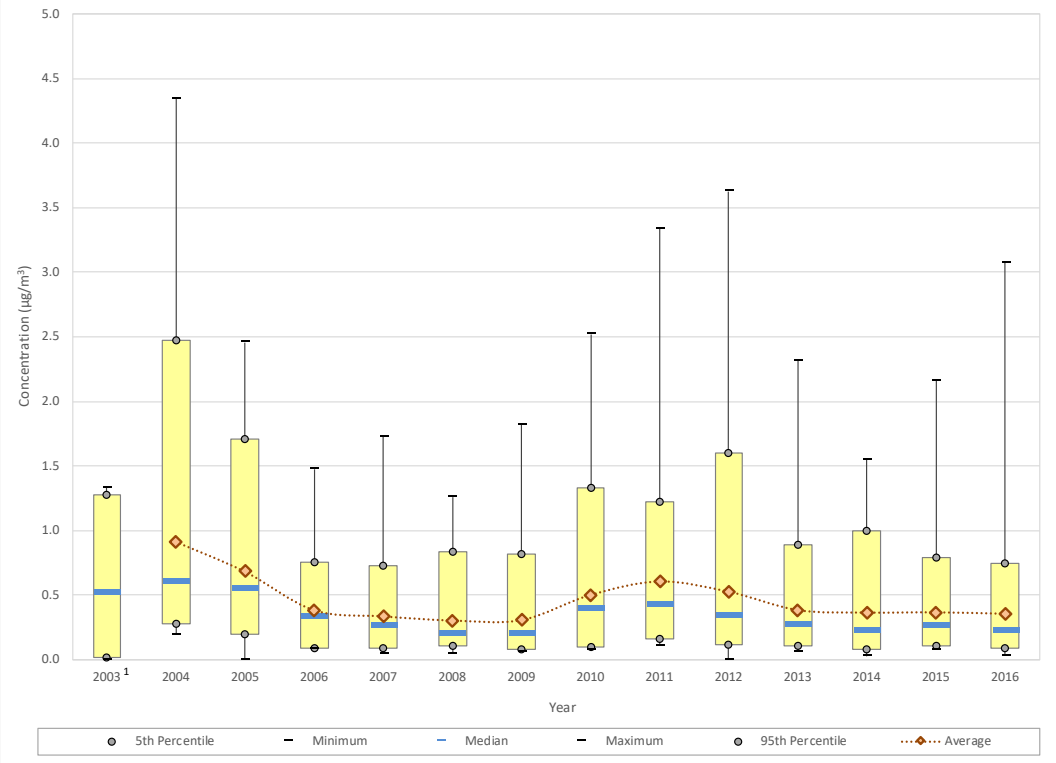
detection in 2005, three in 2006, four in 2009, 12 in 2010, and 11 in 2011. The number of measured detections increased by a factor of five for 2012, with a similar number for each year after.

- The maximum 1,2-dichloroethane concentration was measured in 2006 (3.44 µg/m^3); no other 1,2-dichloroethane concentration measured at DEMI is greater than 0.2 µg/m^3. The magnitude of this outlier explains why the 1-year average concentration for 2006 is five times greater than the 95th percentile (there were only three measured detections in 2006).

- As the number of measured detections increase, so do each of the corresponding statistical metrics shown in Figure 14-18. The 1-year average concentration increased significantly from 2011 to 2012, when the number of non-detects fell from 50 to 10. This number decreased by half again for 2013, when the 1-year average and median concentrations were at a maximum.

- A slight decreasing trend is shown in the central tendency parameters between 2013 and 2016.

Figure 14-19. Yearly Statistical Metrics for Ethylbenzene Concentrations Measured at DEMI



[1] A 1-year average is not presented due to low completeness for 2003.

Observations from Figure 14-19 for ethylbenzene concentrations measured at DEMI include the following:

- The maximum ethylbenzene concentration was measured at DEMI in September 2004 (4.35 µg/m^3). Three additional ethylbenzene concentrations greater than 3 µg/m^3 have been measured at DEMI (one each in 2011, 2012, and 2016). In total, 13 concentrations greater than 2 µg/m^3 have been measured at DEMI.

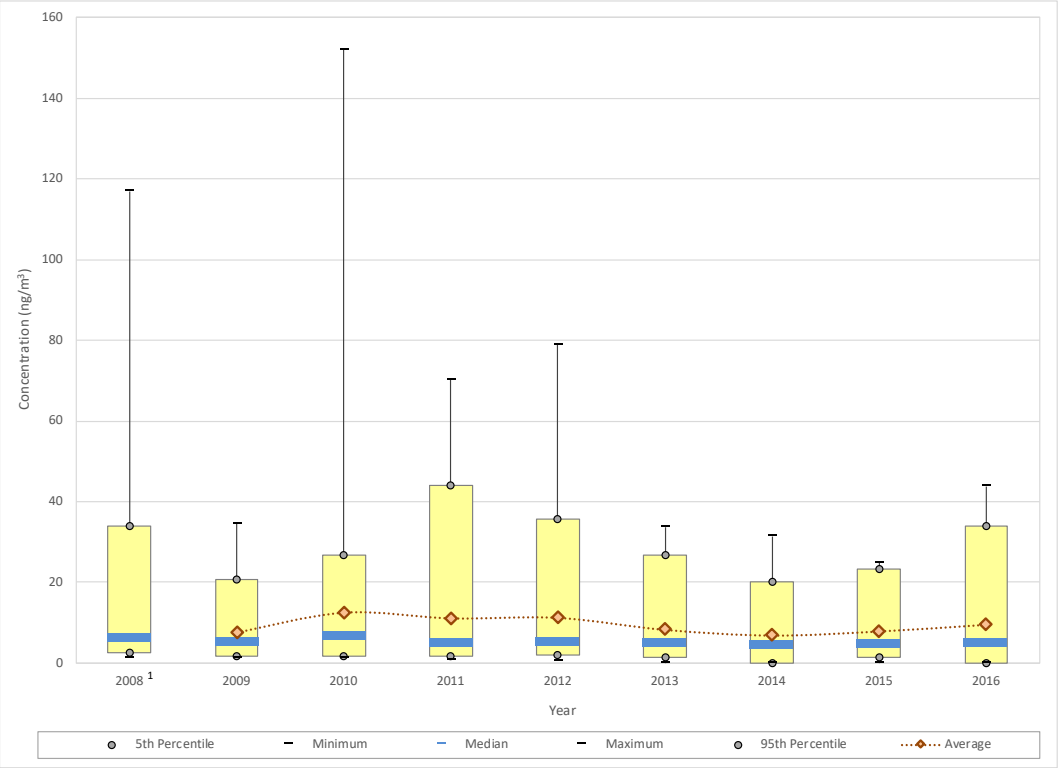
- A steady decreasing trend in the 1-year average concentration is shown after 2004, although the rate of decrease levels out after 2006, with the 1-year average reaching a minimum for 2008 (0.30 µg/m^3). Little change is shown for 2009.

- Increasingly higher maximum ethylbenzene concentrations were measured at DEMI after 2008 and continues through 2012. The 1-year average concentration increases significantly through 2011, then decreases slightly for 2012, despite the large range of concentrations measured. While the maximum concentration increased for 2012, the minimum concentration decreased (and one non-detect was measured). The number of ethylbenzene concentrations at the lower end of the concentration range (those less than 0.25 µg/m^3) nearly doubled from 2011 to 2012 (up from 11 to 19), resulting in the slight decreases shown in the central tendency statistics for 2012, despite a few higher concentrations measured.

- This decreasing trend continued through 2014. Concentrations less than 0.25 µg/m^3 account for an even greater percentage of the measurements in 2013 and 2014, accounting for more than 40 percent of the measurements for 2013 and more than half for 2014.

- Relatively little change is shown in the central tendency parameters between 2014 and 2016, aside from the increasing maximum concentration. Ethylbenzene concentrations less than 0.25 µg/m^3 continued to account for around half of the measurements during this time. Between 2013 and 2016, each of the 1-year average ethylbenzene concentrations fell between 0.35 µg/m^3 and 0.40 µg/m^3.

Figure 14-20. Yearly Statistical Metrics for Fluorene Concentrations Measured at DEMI



[1] A 1-year average is not presented because sampling under the NMP did not begin until April 2008.

Observations from Figure 14-20 for fluorene concentrations measured at DEMI include the following:

- The trends graph for fluorene resembles the trends graph for acenaphthene (Figure 14-13) in a number of ways.

- The maximum fluorene concentration (152 ng/m^3) was measured at DEMI on August 18, 2010, the same day that the maximum acenaphthene concentration was measured. Two additional measurements greater than 100 ng/m^3 have been measured at DEMI, with all three measured during the month of August (one in 2008 and another in 2010). All eight concentrations greater than 50 ng/m^3 were measured in June, July, or August of a given year and all 59 concentrations greater than or equal to 20 ng/m^3 were measured at DEMI between May and September.

- Although all of the statistical metrics increased (at least slightly) from 2009 to 2010, the 1-year average concentration is being driven by the two highest concentrations measured in 2010 (both greater than 100 ng/m^3). The next highest concentration measured in 2010 is considerably less (44.8 ng/m^3). If the two highest concentrations were excluded from the calculation, the 1-year average concentration for 2010 would decrease from 12.62 ng/m^3 to 8.40 ng/m^3, which is less than a 1 ng/m^3 increase from 2009.

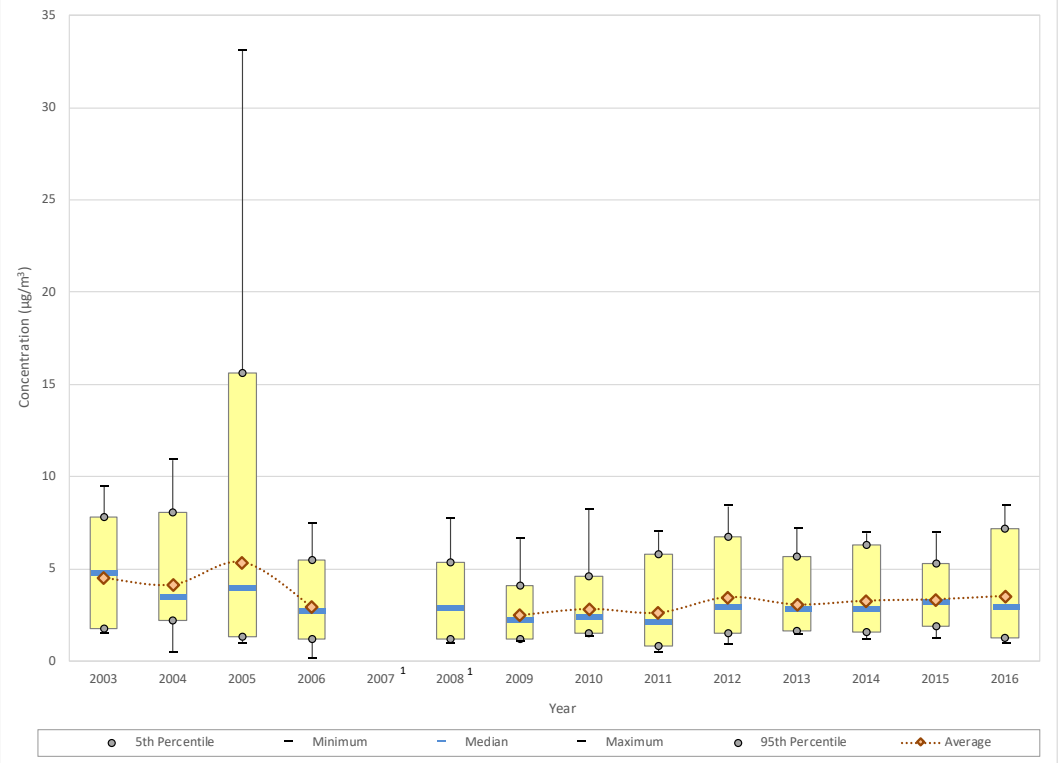
- The 95th percentile increased steadily between 2009 and 2011. The number of concentrations greater than 25 ng/m^3 increased from one to three to seven during this

period. There were also seven concentrations greater than 25 ng/m^3 measured in 2012, even though the 95th percentile exhibits a slight decrease.

- All of the statistical parameters exhibit decreases from 2012 to 2013 and again for 2014 (except the minimum concentration, which did not change). Both the 1-year average and median concentrations are at a minimum for 2014. These central tendency parameters both exhibit slight increases for 2015 and 2016.

- Between 2011 and 2016, the median concentrations have varied by less than 1 ng/m^3, ranging from 4.58 ng/m^3 (2014) to 5.42 ng/m^3 (2012). The 1-year average concentrations exhibit more variability, ranging from 6.93 ng/m^3 (2014) to 11.32 ng/m^3 (2012). With the relatively large confidence intervals associated with these 1-year average concentrations, the changes shown are not statistically significant.

Figure 14-21. Yearly Statistical Metrics for Formaldehyde Concentrations Measured at DEMI



[1] A 1-year average is not presented because data from March 2007 to March 2008 was invalidated.

Observations from Figure 14-21 for formaldehyde concentrations measured at DEMI include the following:

- Carbonyl compounds have been sampled continuously at DEMI under the NMP since 2003 but due to a leak in the sample line, samples collected between March 13, 2007 through March 25, 2008 were invalidated. With only 12 valid samples in 2007, no statistical metrics are provided. With most samples collected during the first quarter

of 2008 invalidated, a 1-year average concentration is not presented for 2008, although the range of measurements is provided.

- The five highest formaldehyde concentrations measured at DEMI were measured in 2005 and ranged from 13.3 µg/m^3 to 33.1 µg/m^3. All nine formaldehyde concentrations greater than 9 µg/m^3 were measured during the first 3 years of sampling.

- All of the statistical parameters exhibit decreases from 2005 to 2006, with a significant decrease in the 1-year average concentration, which decreased from 5.35 µg/m^3 to 2.92 µg/m^3. Even though a 1-year average could not be calculated for 2008, the concentration profile changed little from 2006 to 2008.

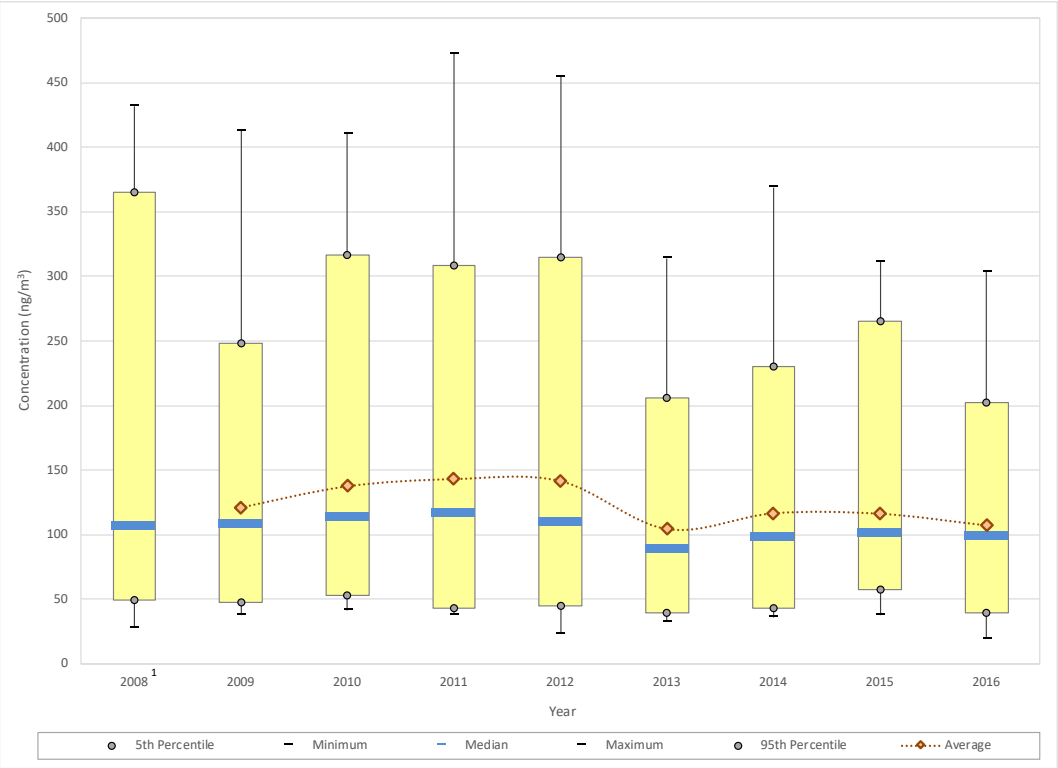
- The range of formaldehyde concentrations measured is at a minimum for 2009; the majority of formaldehyde concentrations, as indicated by the difference between the 5th and 95th percentiles, fell within the tightest range in 2009, indicating reduced variability within the measurements in 2009.

- Between 2006 and 2011, less than 0.5 µg/m^3 separates the 1-year average concentrations, which ranged from 2.46 µg/m^3 (2009) and 2.92 µg/m^3 (2006).

- All of the statistical parameters exhibit increases for 2012, with the 1-year average concentration greater than 3 µg/m^3 for the first time since 2005. This is also true for the median concentration.

- The 1-year average formaldehyde concentration has varied between 3 µg/m^3 and 3.5 µg/m^3 over the last five years of sampling at DEMI.

Figure 14-22. Yearly Statistical Metrics for Naphthalene Concentrations Measured at DEMI



[1] A 1-year average is not presented because sampling under the NMP did not begin until April 2008.

Observations from Figure 14-22 for naphthalene concentrations measured at DEMI include the following:

- The maximum naphthalene concentration was measured at DEMI in July 2011 (473 ng/m^3); five additional measurements greater than 400 ng/m^3 have been measured at DEMI (at least one in each of the first five years of sampling).

- The 95th percentile is at a maximum for the first year of sampling. While at least one naphthalene concentration greater than 300 ng/m^3 has been measured during each year of sampling, these concentrations account for the highest percentage (10 percent) of the measurements in 2008. Only one of these concentrations was measured in 2009, when the 95th percentile decreased by more than 100 ng/m^3. Note that the median concentration changed little between 2008 and 2009.

- With the exception of the maximum concentration, all of the statistical parameters exhibit increases from 2009 to 2010. Relatively little change is shown in the naphthalene concentrations measured at DEMI between 2010 and 2012.

- The smallest range of naphthalene concentrations was measured in 2013, with all of the statistical parameters exhibiting decreases except the minimum concentration. Both the 1-year average and median concentrations are at a minimum for 2013, with the median concentration less than 100 ng/m^3 for the first time.

- All of the statistical parameters exhibit increases for 2014, with most exhibiting additional increases for 2015. All of the statistical parameters exhibit decreases for 2016; the minimum, maximum, and 95th percentiles are at a minimum for 2016.

14.4 Additional Risk-Based Screening Evaluations

The following risk-based screening evaluations were conducted to characterize risk related to the air toxics measured at the Michigan monitoring site. Refer to Sections 3.2, 3.4.2.3, and 3.4.2.4 for definitions and explanations regarding the various toxicity factors, time frames, and calculations associated with these risk-based screenings.

14.4.1 Cancer Risk and Noncancer Hazard Approximations

For the pollutants of interest for the Michigan site, risk was examined by calculating cancer risk and noncancer hazard approximations for each year annual average concentrations could be calculated. These approximations can be used as risk estimates for cancer and noncancer effects attributable to the pollutants of interest. Although the use of these approximations is limited, they may help identify where policy-makers want to shift their air monitoring priorities. Refer to Section 3.4.2.3 for an explanation of how cancer risk and noncancer hazard approximations are calculated and what limitations are associated with them. Annual averages, cancer UREs and/or noncancer RfCs, and cancer risk and noncancer hazard approximations are presented in Table 14-4, where applicable. Cancer risk approximations are presented as probabilities while the noncancer hazard approximations are ratios and thus, unitless values.

Observations from Table 14-4 include the following:

- Formaldehyde has the highest annual average concentrations for DEMI, followed by acetaldehyde, benzene, and carbon tetrachloride.

- Formaldehyde has the highest cancer risk approximations for DEMI (43.31 in-a-million for 2015 and 46.02 in-a-million for 2016), with all other cancer risk approximations an order of magnitude lower. Benzene is the only other pollutant of interest with cancer risk approximations greater than 5 in-a-million.

- None of the pollutants of interest for DEMI have noncancer hazard approximations greater than 1.0, indicating that no adverse noncancer health effects are expected from these individual pollutants. The pollutant with the highest noncancer hazard approximation for DEMI is formaldehyde (0.34 for 2015 and 0.36 for 2016).

Table 14-4. Risk Approximations for the Michigan Monitoring Site

Pollutant	Cancer URE $(\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	2015				2016			
			# of Measured Detections vs. # of Samples	Annual Average $(\mu g/m^3)$	Risk Approximations		# of Measured Detections vs. # of Samples	Annual Average $(\mu g/m^3)$	Risk Approximations	
					Cancer (in-a-million)	Noncancer (HQ)			Cancer (in-a-million)	Noncancer (HQ)
Dearborn, Michigan - DEMI										
Acetaldehyde	0.0000022	0.009	60/60	1.77 ± 0.14	3.89	0.20	61/61	1.96 ± 0.18	4.31	0.22
Benzene	0.0000078	0.03	60/60	0.80 ± 0.08	6.23	0.03	60/60	0.68 ± 0.08	5.33	0.02
1,3-Butadiene	0.00003	0.002	60/60	0.09 ± 0.01	2.78	0.05	59/60	0.08 ± 0.01	2.47	0.04
Carbon Tetrachloride	0.000006	0.1	60/60	0.67 ± 0.02	4.01	0.01	60/60	0.66 ± 0.03	3.96	0.01
1,2-Dichloroethane	0.000026	2.4	58/60	0.07 ± 0.01	1.78	<0.01	54/60	0.06 ± 0.01	1.57	<0.01
Ethylbenzene	0.0000025	1	60/60	0.37 ± 0.09	0.92	<0.01	60/60	0.36 ± 0.11	0.89	<0.01
Formaldehyde	0.000013	0.0098	60/60	3.33 ± 0.31	43.31	0.34	61/61	3.54 ± 0.47	46.02	0.36
Acenaphthene[a]	0.000088	--	54/62	8.86 ± 2.14	0.78	--	61/61	10.30 ± 3.05	0.91	--
Fluorene[a]	0.000088	--	59/62	7.93 ± 1.69	0.70	--	54/61	9.57 ± 2.69	0.84	--
Naphthalene[a]	0.000034	0.003	62/62	116.18 ± 15.46	3.95	0.04	61/61	107.01 ± 14.51	3.64	0.04

-- = A Cancer URE or Noncancer RfC is not available.

[a] Average concentrations provided below the blue line are presented in ng/m^3 for ease of viewing.

14.4.2 Risk-Based Emissions Assessment

In addition to the risk-based screening discussed above, this section presents an evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 14-5 presents the 10 pollutants with the highest emissions from the 2014 NEI (version 1) that have cancer toxicity factors. Table 14-5 also presents the 10 pollutants with the highest toxicity-weighted emissions, based on the weighting schema described in Section 3.4.2.4. Lastly, Table 14-5 provides the 10 pollutants of interest with the highest cancer risk approximations (in-a-million) for DEMI, as presented in Table 14-4. The emissions, toxicity-weighted emissions, and cancer risk approximations are shown in descending order in Table 14-5. Cancer risk approximations for 2015 are presented in green while approximations for 2016 are in white. Table 14-6 presents similar information, but is limited to those pollutants with noncancer toxicity factors.

Because not all pollutants have both cancer and noncancer toxicity factors, the highest emitted pollutants in the cancer table may be different from the noncancer table, although the actual quantity of emissions is the same. The cancer risk and noncancer hazard approximations based on each site's annual averages are limited to the pollutants of interest identified for each site. In addition, the cancer risk and noncancer hazard approximations are limited to those pollutants with enough data to meet the criteria for annual averages to be calculated. A more in-depth discussion of this analysis is provided in Section 3.4.2.4. Similar to the cancer risk and noncancer hazard approximations provided in Section 14.4.1, this analysis may help policy-makers prioritize their air monitoring activities.

Table 14-5. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Michigan Monitoring Site

Top 10 Total Emissions for Pollutants with Cancer UREs (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Dearborn, Michigan (Wayne County) - DEMI					
Benzene	531.30	Coke Oven Emissions, PM	2.09E-02	Formaldehyde	46.02
Formaldehyde	482.82	Formaldehyde	6.28E-03	Formaldehyde	43.31
Ethylbenzene	282.77	Benzene	4.14E-03	Benzene	6.23
Acetaldehyde	256.11	POM, Group 5a	3.09E-03	Benzene	5.33
1,3-Butadiene	78.42	1,3-Butadiene	2.35E-03	Acetaldehyde	4.31
Naphthalene	44.94	Naphthalene	1.53E-03	Carbon Tetrachloride	4.01
Trichloroethylene	26.11	POM, Group 3	1.33E-03	Carbon Tetrachloride	3.96
Coke Oven Emissions, PM	21.14	Hexavalent Chromium, PM	8.93E-04	Naphthalene	3.95
POM, Group 2b	9.55	POM, Group 2b	8.41E-04	Acetaldehyde	3.89
POM, Group 2d	7.18	Ethylbenzene	7.07E-04	Naphthalene	3.64

[1] Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Table 14-6. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the Michigan Monitoring Site

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific) [1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Hazard Approximation (HQ)**
Dearborn, Michigan (Wayne County) - DEMI					
Hydrochloric acid	3,196.06	Acrolein	1,592,409.10	Formaldehyde	0.36
Toluene	1,736.71	Hydrochloric acid	159,802.76	Formaldehyde	0.34
Xylenes	994.97	Formaldehyde	49,267.35	Acetaldehyde	0.22
Methanol	830.42	1,3-Butadiene	39,210.31	Acetaldehyde	0.20
Benzene	531.30	Acetaldehyde	28,456.78	1,3-Butadiene	0.05
Formaldehyde	482.82	Cyanide Compounds, PM	24,633.50	1,3-Butadiene	0.04
Hexane	354.50	Benzene	17,710.14	Naphthalene	0.04
Ethylene glycol	309.96	Manganese, PM	15,439.09	Naphthalene	0.04
Ethylbenzene	282.77	Naphthalene	14,978.94	Benzene	0.03
Acetaldehyde	256.11	Trichloroethylene	13,057.09	Benzene	0.02

[1] Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Observations from Table 14-5 include the following:

- Benzene, formaldehyde, and ethylbenzene are the highest emitted pollutants with cancer UREs in Wayne County.

- The pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) for Wayne County are coke oven emissions, formaldehyde, and benzene.

- Seven of the highest emitted pollutants in Wayne County also have the highest toxicity-weighted emissions. Wayne County is one of only two counties with an NMP site for which coke oven emissions appear on both emissions-based lists.

- Formaldehyde has the highest cancer risk approximations for DEMI. This pollutant also appears on both emissions-based lists, ranking second for both quantity emitted and toxicity-weighted emissions. Benzene and naphthalene are also pollutants of interest for DEMI that appear on both emissions-based lists.

- Acetaldehyde is another pollutant of interest whose cancer risk approximations appear in Table 14-5 for DEMI. Acetaldehyde is one of the highest emitted pollutants in Wayne County but does not appear among those with the highest toxicity-weighted emissions (it ranks 12th).

- Carbon tetrachloride, the remaining pollutant of interest shown in Table 14-5, does not appear on either emissions-based list.

Observations from Table 14-6 include the following:

- Hydrochloric acid, toluene, and xylenes are the highest emitted pollutants with noncancer RfCs in Wayne County. The quantity of emissions for the highest-ranking pollutants in Table 14-6 is an order of magnitude higher than the quantity of emissions for the highest-ranking pollutants in Table 14-5.

- The pollutants with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) for Wayne County are acrolein, hydrochloric acid, and formaldehyde. Although acrolein was sampled for at DEMI, this pollutant was excluded from the pollutants of interest designation and thus, subsequent risk-based screening evaluations due to questions about the consistency and reliability of the measurements, as discussed in Section 3.2.

- Four of the highest emitted pollutants in Wayne County also have the highest toxicity-weighted emissions.

- Formaldehyde has the highest noncancer hazard approximations for DEMI (although none of the pollutants of interest have associated noncancer hazard approximations greater than 1.0). Formaldehyde emissions rank sixth highest for Wayne County while the toxicity-weighted emissions rank third (among the pollutants with noncancer RfCs). Acetaldehyde and benzene also appear on all three lists for DEMI.

- Naphthalene and 1,3-butadiene, the two remaining pollutants of interest for DEMI, both appear among those with the toxicity-weighted emissions in Wayne County, but do not appear among the highest emitted.

14.5 Summary of the 2015-2016 Monitoring Data for DEMI

Results from several of the data analyses described in this section include the following:

- ❖ *Sixteen pollutants failed screens for DEMI, including three carbonyl compounds, eight VOCs, and five PAHs.*

- ❖ *Of the site-specific pollutants of interest, formaldehyde and acetaldehyde had the highest annual average concentrations for DEMI. None of the other site-specific pollutants of interest had annual average concentrations greater than 1 µg/m^3.*

- ❖ *The maximum ethylbenzene concentration measured across the program was measured at DEMI in 2016.*

- ❖ *DEMI's annual average concentration of naphthalene for 2015 is the highest annual average concentration among NMP sites sampling PAHs.*

- ❖ *A significant decrease in benzene concentrations occurred at DEMI for many years, although concentrations have leveled off in recent years. Concentrations of acetaldehyde have a slow, steady increasing trend over the last several years of sampling.*

- ❖ *Formaldehyde has the highest cancer risk approximations among the pollutants of interest for DEMI. None of the pollutants of interest for DEMI have noncancer hazard approximations greater than an HQ of 1.0.*

15.0 Site in Missouri

This section summarizes those data from samples collected at the NATTS site in Missouri and generated by ERG, EPA's contract laboratory for the NMP, over the 2015 and 2016 monitoring efforts. This section also examines the spatial and temporal characteristics of the ambient monitoring concentrations and reviews them through the context of risk. Readers are encouraged to refer to Sections 1 through 4 for detailed discussions and definitions regarding the various data analyses presented below.

> Data generated by sources other than ERG, EPA's contract laboratory for the NMP, are not included in the data analyses contained in this report.

15.1 Site Characterization

This section characterizes the S4MO monitoring site by providing a description of the nearby area surrounding the monitoring site; plotting emissions sources surrounding the monitoring site; and presenting traffic data and other characterizing information for each site. This information is provided to give the reader insight regarding factors that may influence the air quality near the site and assist in the interpretation of the ambient measurements.

The S4MO monitoring site is located in the St. Louis, MO-IL CBSA. Figure 15-1 presents a composite satellite image retrieved from ArcGIS Explorer showing the monitoring site and its immediate surroundings. Figure 15-2 identifies nearby point source emissions locations by source category, as reported in the 2014 NEI for point sources, version 1. Note that only sources within 10 miles of the site are included in the facility counts provided in Figure 15-2. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have a direct effect on the air quality at the monitoring site. Further, this boundary provides both the proximity of emissions sources to the monitoring site as well as the quantity of such sources within a given distance of the site. Sources outside the 10-mile boundary are still visible on the map for reference but have been grayed out to emphasize emissions sources within the boundary. Table 15-1 provides supplemental geographical information such as land use, location setting, and locational coordinates. Each figure and table is discussed in detail in the paragraphs that follow.

Figure 15-1. St. Louis, Missouri (S4MO) Monitoring Site

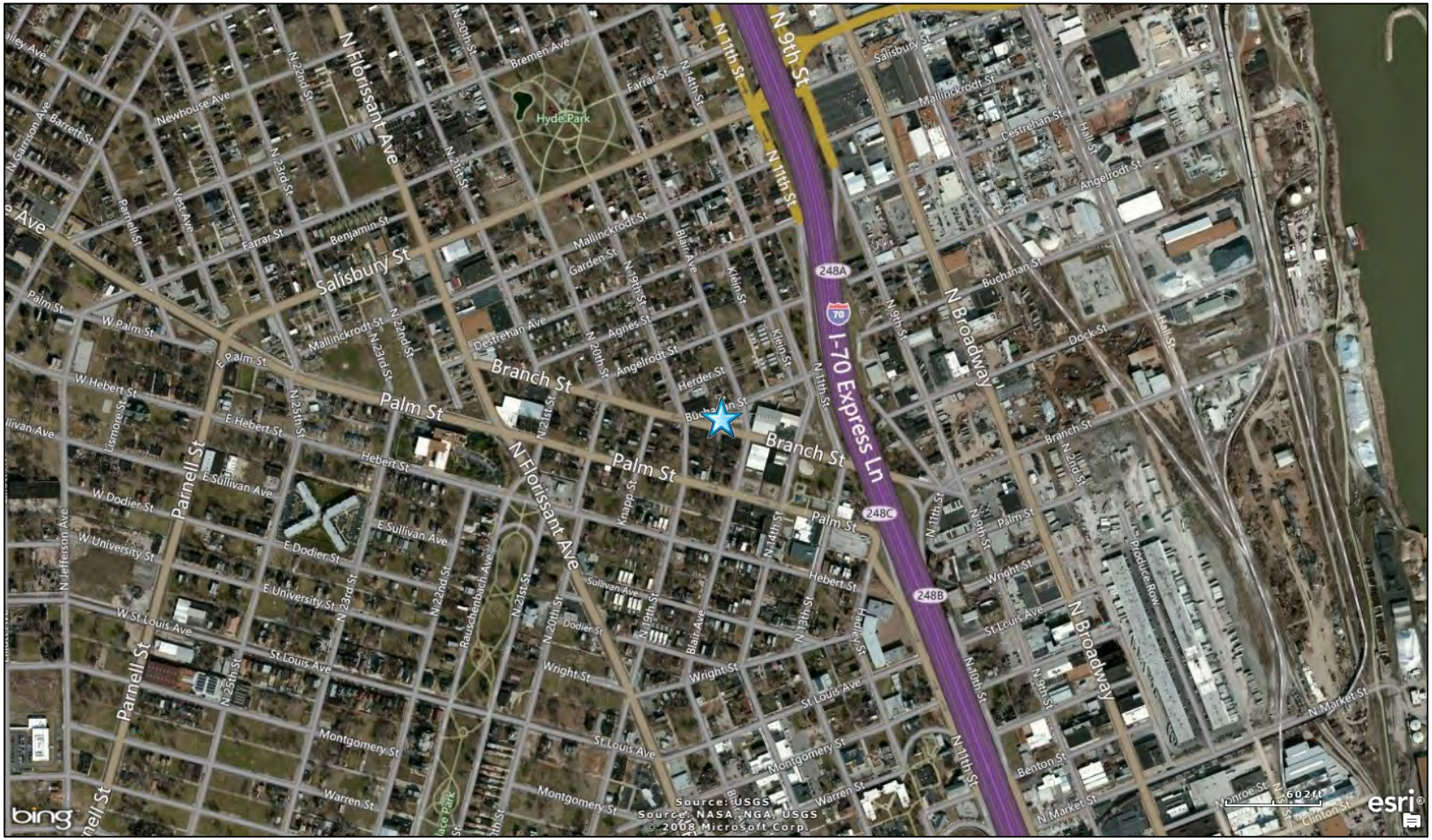


Figure 15-2. NEI Point Sources Located Within 10 Miles of S4MO

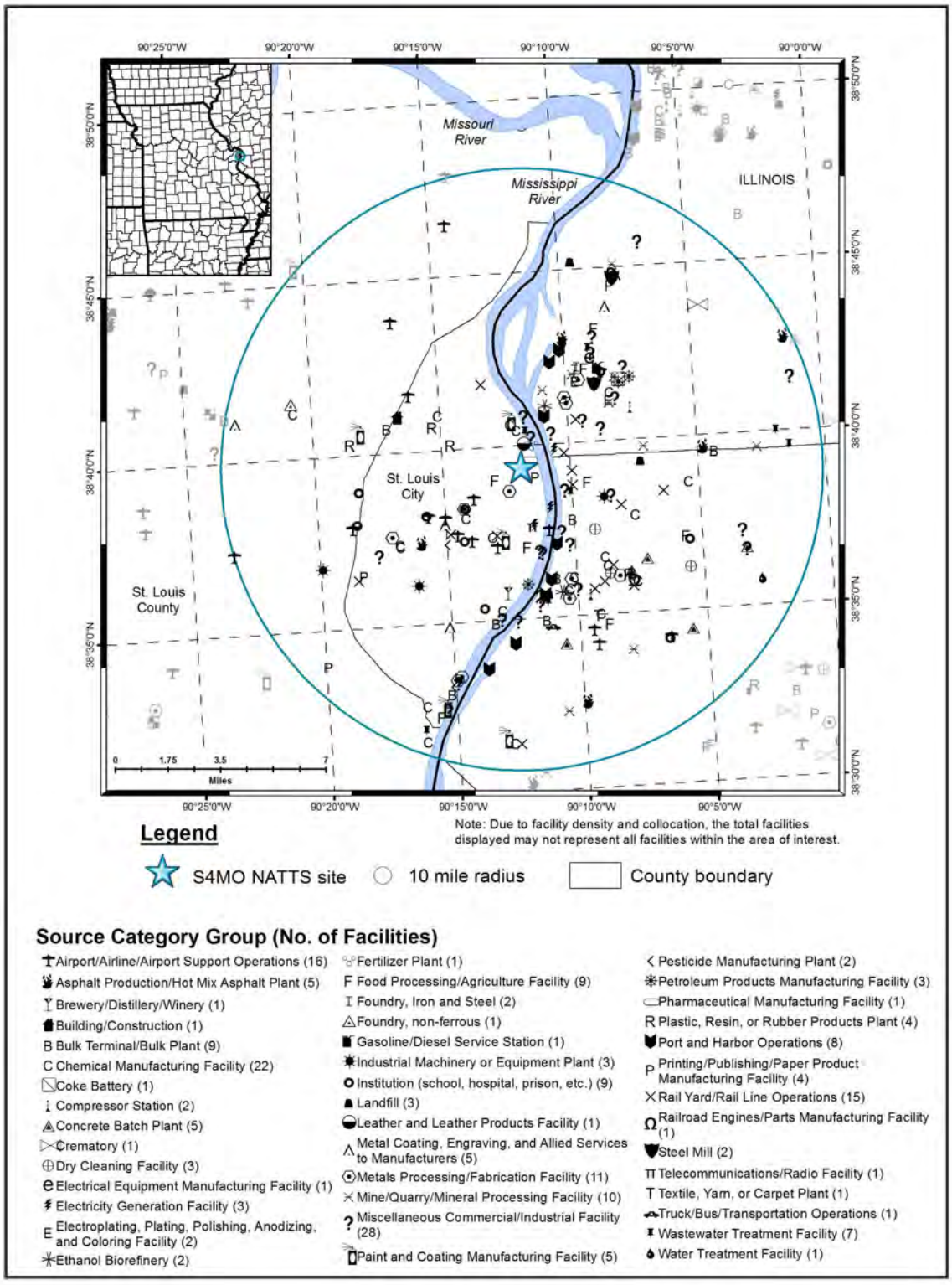


Table 15-1. Geographical Information for the Missouri Monitoring Site

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Annual Average Daily Traffic[1]	Intersection Used for Traffic Data
S4MO	29-510-0085	St. Louis	St. Louis City	St. Louis, MO-IL	38.656498, -90.198646	Residential	Urban/City Center	57,558	I-70 near Rte 115/Salisbury St

[1]AADT reflects 2015 data (MO DOT, 2015)
BOLD ITALICS = EPA-designated NATTS Site

S4MO is located in central St. Louis. Figure 15-1 shows that the S4MO monitoring site is located less than one-quarter mile west of I-70. The Mississippi River, which separates Missouri and Illinois, is less than 1 mile east of the site. Although the area directly around the monitoring site is primarily residential, industrial facilities are located nearby, primarily just on the other side of I-70. Figure 15-2 shows that a large number of point sources are located within 10 miles of S4MO, particularly on the east side of the Missouri/Illinois border. The source categories with the greatest number of point sources surrounding S4MO include chemical manufacturing facilities; airport and airport support operations, which include airports and related operations as well as small runways and heliports, such as those associated with hospitals or television stations; rail yard/rail line operations; metals processing/fabrication facilities; and mines, quarries, and mineral processing facilities. Within 1 mile of S4MO are a pharmaceutical manufacturing facility, a printing and publishing facility, a leather products facility, a fertilizer plant, and a metals processing/fabrication facility.

In addition to providing city, county, CBSA, and land use/location setting information, Table 15-1 also contains traffic volume information for the site as well as the location for which the traffic volume was obtained. This information is provided because emissions from motor vehicles can significantly affect concentrations measured at a given monitoring site. The traffic volume experienced near S4MO is nearly 58,000 and ranks 17th highest among other NMP sites, which falls in the upper third of traffic volumes compared to other NMP sites. The traffic estimate provided is for I-70 near Route 115/Salisbury Street.

15.2 Pollutants of Interest

The risk-based screening process described in Section 3.2 was performed for the S4MO monitoring site to identify site-specific "pollutants of interest," which allows analysts and readers to focus on a subset of pollutants through the context of risk. Each pollutant's preprocessed daily measurement was compared to its associated risk screening value. If the concentration was greater than the risk screening value, then the concentration "failed the screen." The site-specific results of this risk-based screening process are presented in Table 15-2 and incorporate measurements from both 2015 and 2016. Pollutants of interest are those for which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens and are shaded in gray in Table 15-2. It is important to note which pollutants were sampled for at each site when reviewing the results of this analysis. VOCs, PAHs, carbonyl compounds, and metals (PM_{10}) were sampled for at S4MO.

Table 15-2. 2015-2016 Risk-Based Screening Results for the Missouri Monitoring Site

Pollutant	Screening Value (µg/m^3)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
St. Louis, Missouri - S4MO						
Acetaldehyde	0.45	120	120	100.00	10.90	10.90
Arsenic (PM_{10})	0.00023	120	121	99.17	10.90	21.80
Benzene	0.13	120	120	100.00	10.90	32.70
Carbon Tetrachloride	0.17	120	120	100.00	10.90	43.60
Formaldehyde	0.077	120	120	100.00	10.90	54.50
1,3-Butadiene	0.03	119	119	100.00	10.81	65.30
1,2-Dichloroethane	0.038	114	114	100.00	10.35	75.66
Naphthalene	0.029	107	118	90.68	9.72	85.38
p-Dichlorobenzene	0.091	50	97	51.55	4.54	89.92
Fluorene	0.011	27	100	27.00	2.45	92.37
Acenaphthene	0.011	23	107	21.50	2.09	94.46
Ethylbenzene	0.4	16	120	13.33	1.45	95.91
Hexachloro-1,3-butadiene	0.045	10	12	83.33	0.91	96.82
Manganese (PM_{10})	0.03	10	121	8.26	0.91	97.73
Nickel (PM_{10})	0.0021	6	121	4.96	0.54	98.27
Benzo(a)pyrene	0.00057	5	114	4.39	0.45	98.73
1,2-Dibromoethane	0.0017	5	5	100.00	0.45	99.18
Lead (PM_{10})	0.015	3	121	2.48	0.27	99.46
Propionaldehyde	0.8	3	117	2.56	0.27	99.73
Cadmium (PM_{10})	0.00056	1	121	0.83	0.09	99.82
Chloroprene	0.0021	1	1	100.00	0.09	99.91
Fluoranthene	0.011	1	118	0.85	0.09	100.00
Total		1,101	2,227	49.44		

Observations from Table 15-2 include the following:

- Concentrations of 22 pollutants failed at least one screen for S4MO; approximately 49 percent of concentrations for these 22 pollutants were greater than their associated risk screening value (or failed screens).

- S4MO has the highest number of concentrations failing screens (1,101) among all NMP sites, as shown in Table 4-9 of Section 4.2. The failure rate for S4MO, when incorporating all pollutants with screening values, is approximately 20 percent. This is due primarily to the relatively large number of pollutants sampled for at this site, as discussed in Section 4.2.

- Twelve pollutants contributed to 95 percent of failed screens for S4MO and therefore were identified as pollutants of interest for this site. These 12 pollutants include two carbonyl compounds, six VOCs, one PM_{10} metal, and three PAHs. S4MO ties with two other sites for the greatest number of pollutants of interest among NMP sites.

- Acetaldehyde, formaldehyde, benzene, carbon tetrachloride,1,3-butadiene and 1,2-dichloroethane failed 100 percent of screens for S4MO and were detected in all or nearly all the samples collected. 1,2-Dibromoethane and chloroprene also failed 100 percent of screens but were detected in few VOC samples collected (five and one, respectively), and are not pollutants of interest for S4MO.

For each of the data analyses described in the remaining sections, the focus is on the site-specific pollutants of interest identified via the risk-based screening process, as described in Section 3.4.2.

15.3 Concentrations

This section presents various concentration averages used to characterize air toxics concentration levels at the Missouri monitoring site. Where applicable, the following calculations and data analyses were performed for each of the site-specific pollutants of interest:

- Time period-based concentration averages (quarterly and annual) are provided for each monitoring site for each year of monitoring.

- The range of measurements and annual average concentrations are presented graphically for each site to illustrate how the site's concentrations compare to the program-level averages, as presented in Section 4.1.

- Concentration averages and other statistical metrics for 2015, 2016, and from previous years of monitoring are presented in order to characterize concentration trends at each site.

Each data analysis is performed where the applicable criteria are met (as specified in the appropriate sections discussed below) and is limited to the site-specific pollutants of interest. However, site-specific statistical summaries for all pollutants sampled for at S4MO are provided in Appendices J, M, N, and O.

15.3.1 2015 and 2016 Concentration Averages

Quarterly and annual concentration averages for 2015 and 2016 were calculated for the pollutants of interest for the Missouri site, as described in Section 3.1. The *quarterly average concentration* of a particular pollutant is simply the average concentration of the preprocessed daily measurements over a given calendar quarter. Quarterly average concentrations include the substitution of zeros for all non-detects. A site must have a minimum of 75 percent valid samples compared to the total number of samples possible within a given calendar quarter for a quarterly average to be calculated. An *annual average concentration* includes all measured detections and substituted zeros for non-detects for an entire year of sampling. Annual averages were calculated for pollutants where at least three valid quarterly averages could be calculated for a given year and where method completeness was greater than or equal to 85 percent, as presented in Section 2.4. Quarterly and annual average concentrations for the pollutants of interest for S4MO are presented in Table 15-3, where applicable. Note that concentrations of the PAHs and metals are presented in ng/m^3 for ease of viewing. Also note that if a pollutant was not detected in a given calendar quarter, the quarterly average simply reflects “0” because only zeros substituted for non-detects were factored into the quarterly average concentration.

Table 15-3. Quarterly and Annual Average Concentrations of the Pollutants of Interest for the Missouri Monitoring Site

Pollutant	2015						2016					
	# of Detects/ # >MDL/ # Samples	Q1 Avg (µg/m³)	Q2 Avg (µg/m³)	Q3 Avg (µg/m³)	Q4 Avg (µg/m³)	Annual Average (µg/m³)	# of Detects/ # >MDL/ # Samples	Q1 Avg (µg/m³)	Q2 Avg (µg/m³)	Q3 Avg (µg/m³)	Q4 Avg (µg/m³)	Annual Average (µg/m³)
St. Louis, Missouri - S4MO												
Acetaldehyde	60/60/60	1.34 ± 0.21	1.89 ± 0.29	1.85 ± 0.19	1.56 ± 0.35	1.66 ± 0.14	60/60/60	1.12 ± 0.15	1.85 ± 0.45	1.86 ± 0.18	1.58 ± 0.36	1.59 ± 0.16
Benzene	60/60/60	0.80 ± 0.08	0.47 ± 0.07	0.71 ± 0.24	0.67 ± 0.16	0.66 ± 0.08	60/60/60	0.65 ± 0.11	0.46 ± 0.08	0.56 ± 0.09	0.78 ± 0.24	0.62 ± 0.07
1,3-Butadiene	59/59/60	0.08 ± 0.02	0.06 ± 0.02	0.07 ± 0.01	0.09 ± 0.04	0.08 ± 0.01	60/41/60	0.08 ± 0.02	0.08 ± 0.02	0.08 ± 0.02	0.13 ± 0.07	0.09 ± 0.02
Carbon Tetrachloride	60/60/60	0.63 ± 0.04	0.62 ± 0.02	0.66 ± 0.03	0.60 ± 0.03	0.63 ± 0.02	60/60/60	0.63 ± 0.03	0.71 ± 0.04	0.63 ± 0.07	0.62 ± 0.05	0.65 ± 0.02
p-Dichlorobenzene	49/15/60	0.09 ± 0.06	0.13 ± 0.07	0.18 ± 0.09	0.17 ± 0.13	0.14 ± 0.04	48/19/60	0.07 ± 0.04	0.17 ± 0.12	0.33 ± 0.28	0.31 ± 0.26	0.22 ± 0.10
1,2-Dichloroethane	60/55/60	0.09 ± 0.01	0.08 ± 0.01	0.06 ± 0.01	0.07 ± 0.01	0.07 ± <0.01	54/52/60	0.08 ± 0.01	0.09 ± 0.01	0.06 ± 0.02	0.06 ± 0.02	0.07 ± 0.01
Ethylbenzene	60/56/60	0.18 ± 0.04	0.16 ± 0.03	0.23 ± 0.05	0.24 ± 0.09	0.20 ± 0.03	60/60/60	0.18 ± 0.06	0.19 ± 0.05	0.28 ± 0.06	0.34 ± 0.15	0.25 ± 0.05
Formaldehyde	60/60/60	2.20 ± 0.42	3.58 ± 0.93	4.46 ± 0.89	2.14 ± 0.50	3.09 ± 0.42	60/60/60	2.07 ± 0.24	4.32 ± 1.34	4.33 ± 0.73	2.04 ± 0.44	3.19 ± 0.48
Acenaphthene[a]	55/55/58	1.93 ± 0.80	7.54 ± 2.76	13.12 ± 3.04	4.07 ± 1.31	6.51 ± 1.47	52/52/60	1.56 ± 1.04	6.82 ± 3.44	12.81 ± 4.10	3.68 ± 1.71	6.13 ± 1.71
Arsenic (PM_{10})[a]	60/60/60	0.67 ± 0.15	0.80 ± 0.20	1.14 ± 0.26	0.89 ± 0.33	0.88 ± 0.12	61/61/61	0.69 ± 0.13	0.92 ± 0.28	1.00 ± 0.18	0.99 ± 0.41	0.90 ± 0.13
Fluorene[a]	53/53/58	2.65 ± 0.65	7.28 ± 2.23	12.71 ± 2.52	3.66 ± 1.29	6.40 ± 1.31	47/47/60	1.22 ± 0.93	8.09 ± 3.76	14.03 ± 3.86	3.80 ± 1.60	6.67 ± 1.81
Naphthalene[a]	58/58/58	66.81 ± 12.67	62.93 ± 15.35	82.25 ± 14.83	97.69 ± 34.90	78.32 ± 11.77	60/59/60	49.09 ± 14.01	71.87 ± 35.37	74.39 ± 22.30	100.08 ± 37.28	73.48 ± 14.07

[a] Average concentrations provided for the pollutants below the blue line are presented in ng/m³ for ease of viewing.

Observations for S4MO from Table 15-3 include the following:

- The pollutants with the highest annual average concentrations are formaldehyde and acetaldehyde. These are the only pollutants of interest with annual averages greater than 1 $\mu g/m^3$.

- Concentrations of formaldehyde measured at S4MO range from 0.862 $\mu g/m^3$ to 10.7 $\mu g/m^3$. The two highest concentrations measured at S4MO were both measured on June 11th (10.7 $\mu g/m^3$ on June 11, 2016 and 9.23 $\mu g/m^3$ on June 11, 2015). July 17th was also a sample day with relatively high concentrations for both years (8.25 $\mu g/m^3$ on July 17, 2015 and 7.04 $\mu g/m^3$ on July 17, 2016). The quarterly average concentrations of formaldehyde exhibit a seasonal trend, with the second and third quarter averages significantly higher than the remaining quarterly averages for both years, indicating that higher formaldehyde concentrations tended to be measured during the warmer months of the year at S4MO. These quarterly averages also exhibit more variability, as indicated by the larger confidence intervals. All but two of the 13 formaldehyde concentrations greater than 4 $\mu g/m^3$ measured at S4MO in 2015 were measured during the second or third quarters of the year; for 2016, all 16 formaldehyde concentrations greater than 4 $\mu g/m^3$ were measured at S4MO during the second or third quarters. At the lower end of the concentration range, formaldehyde concentrations less than 2 $\mu g/m^3$ were measured at S4MO primarily during the first or fourth quarters of the year; of the 29 formaldehyde concentrations less than 2 $\mu g/m^3$ measured at S4MO, only two were measured outside the first or fourth quarters, with one measured each year.

- Concentrations of acetaldehyde measured at S4MO range from 0.547 $\mu g/m^3$ to 3.68 $\mu g/m^3$. Concentrations of acetaldehyde appear lowest during the first quarter of each year, although the quarterly average concentrations are not statistically different. All 15 acetaldehyde concentrations less than 1 $\mu g/m^3$ were measured at S4MO during the first or fourth quarters of either year. Five concentrations less than 1 $\mu g/m^3$ were measured during 2015, two during the first quarter and three during the fourth (all in December); 10 concentrations less than 1 $\mu g/m^3$ were measured during 2016, seven during the first quarter and three during the fourth (again, all in December).

- Among the VOCs, benzene and carbon tetrachloride have the highest annual average concentrations, the former for 2015 and the latter for 2016, although the annual averages for these two pollutants are similar to each other. Benzene concentrations are more variable, though. Concentrations of benzene measured at S4MO span an order of magnitude, ranging from 0.282 $\mu g/m^3$ to 2.18 $\mu g/m^3$. The second quarter average concentrations of benzene for both years appear lower than the quarterly averages shown for the remaining quarterly averages. A similar observation was made in the 2014 NMP report. None of the 10 benzene concentrations greater than 1 $\mu g/m^3$ were measured during the second quarter of either year (this is also true for the third quarter of 2016).

- Concentrations of carbon tetrachloride measured at S4MO range from 0.347 $\mu g/m^3$ to 0.857 $\mu g/m^3$, with most concentrations falling between 0.50 $\mu g/m^3$ and 0.75 $\mu g/m^3$. The seven highest carbon tetrachloride concentrations (those greater than 0.75 $\mu g/m^3$) were measured in 2016.

- The quarterly average concentrations of 1,3-butadiene exhibit relatively little variability in 2015. This is mostly true for 2016, with the first, second, and third quarterly average concentrations appearing nearly identical to each other; the fourth quarter average concentration, however, does not resemble the others (0.13 ± 0.07 µg/m^3). A review of the data shows that 1,3-butadiene concentrations measured at S4MO range from 0.031 µg/m^3 to 0.419 µg/m^3, plus a single non-detect. Four of the five highest 1,3-butadiene concentrations measured at S4MO (those greater than 0.20 µg/m^3) were measured between October and December 2016 (with the exception in November 2015).

- The quarterly average concentrations of *p*-dichlorobenzene exhibit considerable variability, particularly for 2016, with the quarterly averages for the second half of the year considerably higher than those for the first half of the year, although the confidence intervals shown are relatively large and nearly the same magnitude as the averages themselves. Concentrations of *p*-dichlorobenzene measured at S4MO range from 0.0241 µg/m^3 to 1.80 µg/m^3 and include 23 non-detects. Although the maximum *p*-dichlorobenzene concentration measured across the program was not measured at S4MO, the next five highest concentrations were measured at this site. S4MO is the only NMP site at which more than one *p*-dichlorobenzene concentration greater than 1 µg/m^3 was measured (four, which were all measured during the second half of 2016); *p*-dichlorobenzene concentrations measured at S4MO account for nine of the 19 *p*-dichlorobenzene concentrations greater than 0.5 µg/m^3 measured across the program, the most among all sites sampling VOCs (the next highest site has four).

- Concentrations of ethylbenzene appear higher during the second half of each year, although the differences are not statistically significant. The three highest ethylbenzene concentrations measured at S4MO were measured during the fourth quarter of 2016, including the only concentration greater than 1 µg/m^3 (1.01 µg/m^3). Five of the six ethylbenzene concentrations greater than 0.5 µg/m^3 measured at S4MO were measured in October, November, or December of either year.

- Arsenic is the only PM_{10} metal pollutant of interest for S4MO. For both years, the quarterly average concentrations of arsenic for the third quarter are greater than 1 ng/m^3. A review of the data shows that arsenic concentrations measured at S4MO range from 0.107 ng/m^3 to 3.62 ng/m^3. Thirty-five arsenic concentrations greater than 1 ng/m^3 were measured at S4MO, with 17 measured in 2015 and 18 measured in 2016. The third quarter is the calendar quarter in which the highest number of these concentrations were measured. At the other end of the concentration range, few arsenic concentrations less than 0.5 ng/m^3 were measured at S4MO during the third calendar quarters; of the 24 arsenic concentrations less than 0.5 ng/m^3 measured at this site, only one was measured during the third quarters (none in 2015 and one in 2016).

- Among the three PAHs identified as pollutants of interest for S4MO, naphthalene has the highest annual average concentrations. The concentrations of naphthalene measured at S4MO are highly variable, as indicated by the quarterly averages shown in Table 15-3, each with relatively large confidence intervals. For both years, the fourth quarter average is the highest, nearly 100 ng/m^3 for 2015 and just surpassing this for 2016. Concentrations of naphthalene measured at S4MO range from

0.660 ng/m^3 to 243 ng/m^3. Of the 25 naphthalene concentrations greater than 100 ng/m^3 measured at S4MO, most were measured during the fourth quarter of either year. The three naphthalene concentrations less than 1 ng/m^3 measured at S4MO are among the lowest naphthalene concentrations measured at an NMP in both 2015 and 2016 (only one site has a lower naphthalene concentration, and S4MO is the only site with more than one of these). By comparison, the next lowest naphthalene concentration measured at S4MO is 20.7 ng/m^3.

- Concentrations of acenaphthene and fluorene appear to be highest during the warmer months of the year, based on the quarterly average concentrations, although each of the quarterly averages exhibits a considerable level of variability. A review of the data shows that the 25 highest concentrations of fluorene were measured at S4MO during the second or third quarters of either year; the 23 highest concentrations of acenaphthene were measured at S4MO during the second or third quarters of either year. Higher concentrations of these two PAHs were often measured on the same days. For example, the highest fluorene concentration (27.6 ng/m^3) was measured on August 10, 2016, the same day the second highest acenaphthene concentration (28.0 ng/m^3) was measured; the highest acenaphthene concentration (28.2 ng/m^3) was measured on September 24, 2016, the same day the second highest fluorene concentration (25.4 ng/m^3) was measured.

Tables 4-10 through 4-13 present the NMP sites with the 10 highest annual average concentrations for each of the program-level pollutants of interest. Observations for S4MO from those tables include the following:

- S4MO appears in Tables 4-10 through 4-13 a total of nine times, appearing in each table except Table 4-11 for carbonyl compounds.

- S4MO has the third highest (2016) and sixth highest (2015) annual average concentrations of *p*-dichlorobenzene among NMP sites sampling VOCs, as shown in Table 4-10.

- Both of S4MO's annual average concentrations of acenaphthene and fluorene appear in Table 4-12, though ranking in the lower half of the table. S4MO's annual average concentration of naphthalene for 2015 ranks ninth highest among NMP sites sampling this pollutant.

- S4MO has the sixth (2016) and seventh (2015) highest annual average concentrations of arsenic among NMP sites sampling PM_{10} metals, as shown in Table 4-13.

15.3.2 Concentration Comparison

In order to better illustrate how each site's annual average concentrations compare to the program-level averages, a site-specific box plot was created for each of the site-specific pollutants of interest, where applicable. Thus, box plots were created for the pollutants listed in Table 15-3 for S4MO. Figures 15-3 through 15-14 overlay the site's minimum, annual average, and maximum concentrations for each year onto the program-level minimum, first quartile,

median, average, third quartile, and maximum concentrations, as described in Section 3.4.2.1, and are discussed below. If an annual average concentration could not be calculated, the range of concentrations are still provided in the figures that follow.

Figure 15-3. Program vs. Site-Specific Average Acenaphthene Concentrations

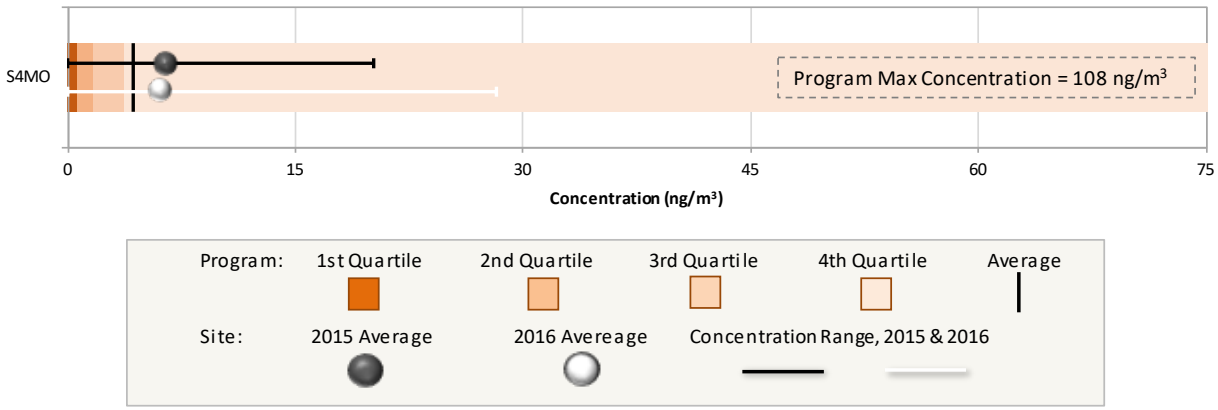


Figure 15-3 presents the box plot for acenaphthene for S4MO and shows the following:

- The program-level maximum acenaphthene concentration (108 ng/m^3) is not shown directly on the box plot in Figure 15-3 because the scale of the box plot would be too large to readily observe data points at the lower end of the concentration range. Thus, the scale of the box plot has been reduced.

- The maximum acenaphthene concentration measured at S4MO (28.2 ng/m^3) is about one-fourth the magnitude of the maximum acenaphthene concentration measured across the program. Four acenaphthene concentrations measured in 2016 are higher than the maximum concentration measured in 2015 (20.2 ng/m^3). Yet, S4MO's annual average concentrations for both years are greater than the program-level average concentration (4.36 ng/m^3).

- There were no non-detects of acenaphthene measured at S4MO while non-detects account for 18 percent of the measurements at the program level.

Figure 15-4. Program vs. Site-Specific Average Acetaldehyde Concentrations

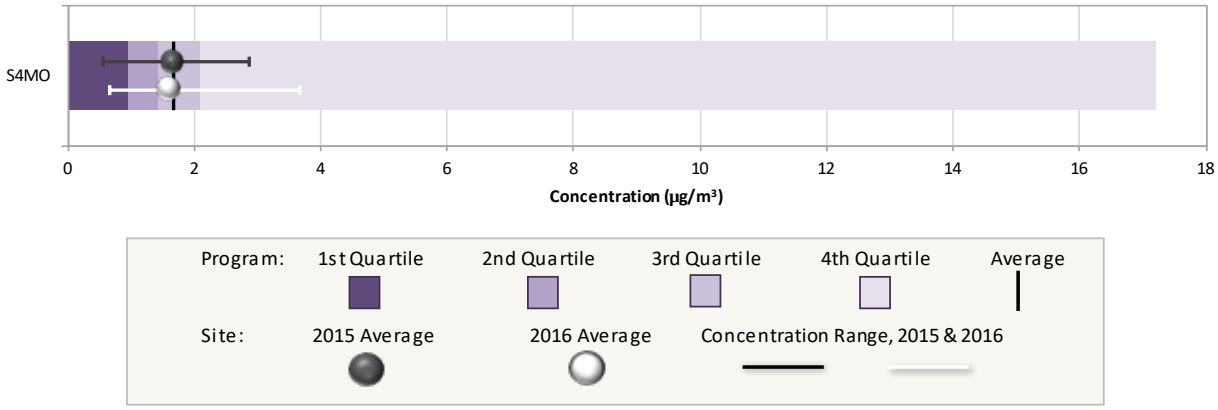


Figure 15-4 presents the box plot for acetaldehyde for S4MO and shows the following:

- The entire range of acetaldehyde concentrations measured at S4MO in 2015 is less than 3 µg/m^3; two concentrations measured in 2016 (3.30 µg/m^3 and 3.68 µg/m^3) are greater than the maximum concentration measured in 2015 (2.87 µg/m^3).

- S4MO's annual average concentration of acetaldehyde for 2015 is similar to the program-level average concentration (1.67 µg/m^3), with the annual average for 2016 just slightly less than these.

- The lowest concentrations of acetaldehyde measured at S4MO were measured on the same dates each year: December 26th and December 8th.

Figure 15-5. Program vs. Site-Specific Average Arsenic (PM_{10}) Concentrations

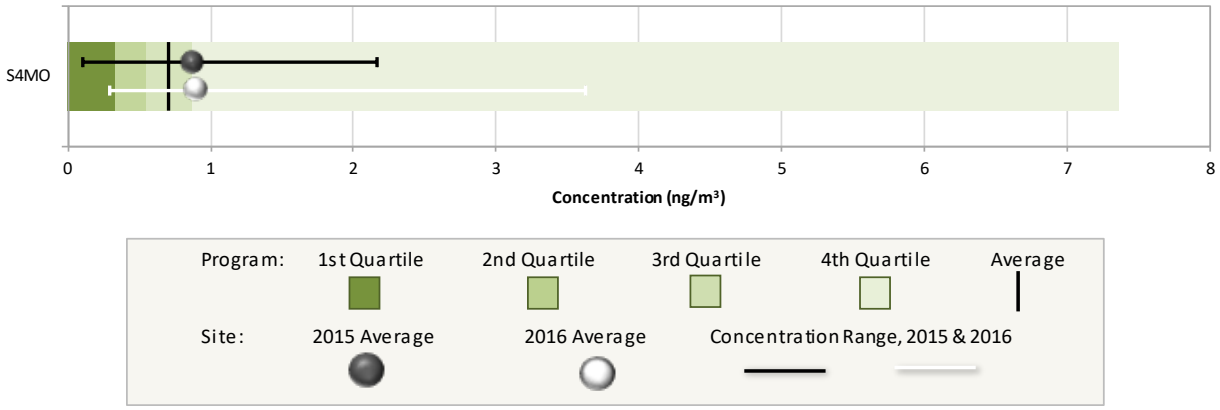


Figure 15-5 presents the box plot for arsenic (PM_{10}) for S4MO and shows the following:

- The maximum arsenic (PM_{10}) concentration measured at S4MO (3.62 ng/m^3) is about one-half the maximum concentration measured across the program. The next highest arsenic concentration measured at S4MO is considerably less (the maximum concentration shown for 2015, 2.17 ng/m^3); several arsenic concentrations of this magnitude were measured at S4MO both years.

- S4MO's annual average concentration of arsenic (PM_{10}) for 2015 is similar to the annual average concentration for 2016. Both annual averages are greater than the program-level average concentration and similar to the program-level third quartile. This site has the sixth and seventh highest annual average concentrations of arsenic among NMP sites sampling PM_{10} metals.

Figure 15-6. Program vs. Site-Specific Average Benzene Concentrations

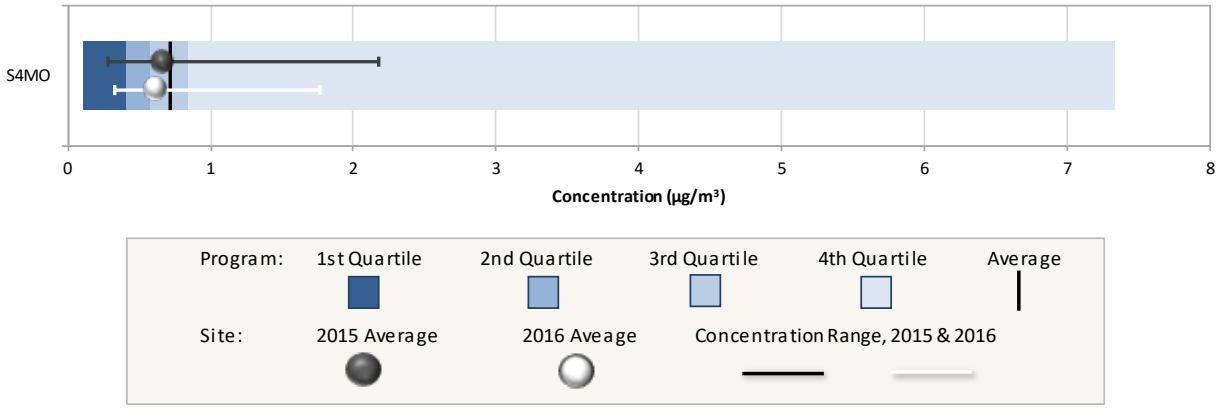


Figure 15-6 presents the box plot for benzene for S4MO and shows the following:

- The range of benzene concentrations measured at S4MO in 2016 is slightly smaller than the range of concentrations measured in 2016, though both are relatively small compared to the range measured at the program-level.

- Both annual average concentrations of benzene for S4MO lie between the program-level median concentration (0.59 µg/m^3) and the program-level average concentration (0.72 µg/m^3).

Figure 15-7. Program vs. Site-Specific Average 1,3-Butadiene Concentrations

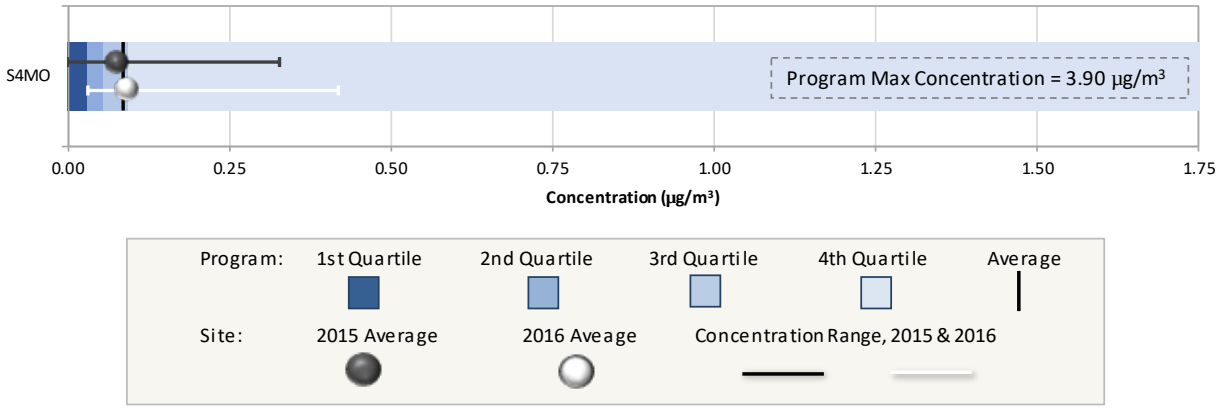


Figure 15-7 presents the box plot for 1,3-butadiene for S4MO and shows the following:

- The program-level maximum 1,3-butadiene concentration (3.90 µg/m^3) is not shown directly on the box plot as the scale has also been reduced to allow for the observation of data points at the lower end of the concentration range.

- If the minimum concentration measured in 2015 (non-detect) and maximum concentration measured in 2016 (0.419 µg/m^3) were excluded, the range of 1,3-butadiene concentrations measured at S4MO would be nearly identical.

- The annual average concentration of 1,3-butadiene for 2015 is just less than the program-level average concentration while the annual average for 2016 is just greater than the program-level average.

Figure 15-8. Program vs. Site-Specific Average Carbon Tetrachloride Concentrations

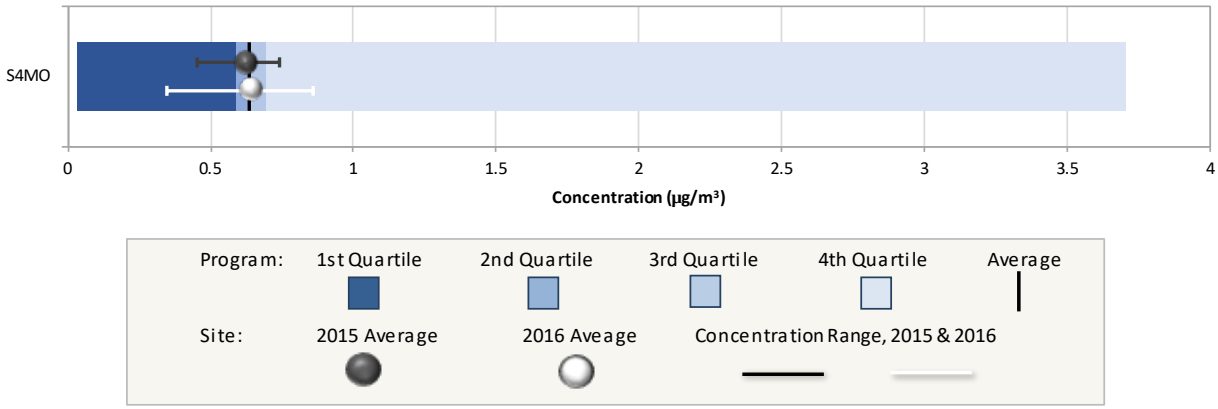


Figure 15-8 presents the box plot for carbon tetrachloride for S4MO and shows the following:

- The program-level median and average concentrations are similar to each other in magnitude (both approximately 0.64 µg/m^3) and thus, are plotted nearly on top of each other.

- The range of carbon tetrachloride concentrations measured at S4MO in 2015 is smaller than the range measured in 2016, although the entire range of concentrations spans just over 0.5 µg/m^3.

- The annual average concentrations of carbon tetrachloride for S4MO are similar to both the program-level median and average concentrations.

Figure 15-9. Program vs. Site-Specific Average *p*-Dichlorobenzene Concentrations

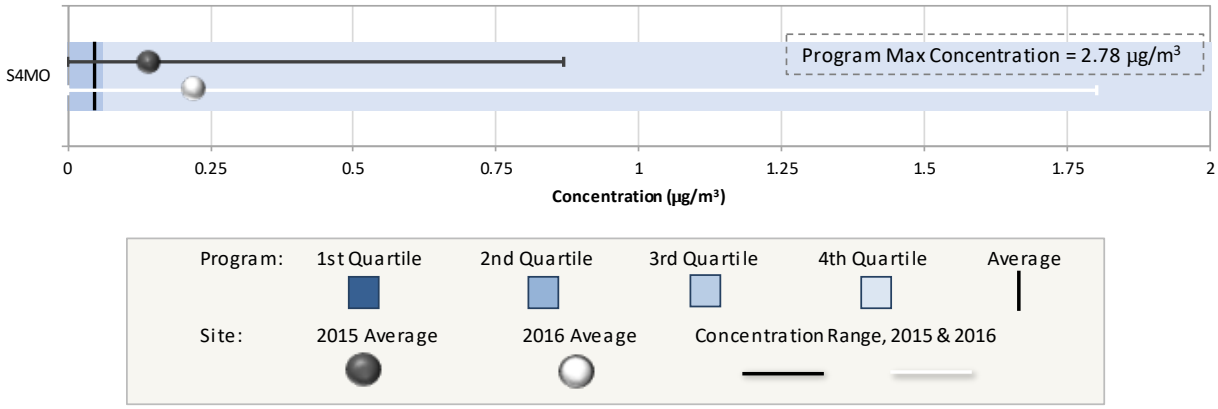


Figure 15-9 presents the box plot for *p*-dichlorobenzene for S4MO and shows the following:

- The program-level maximum *p*-dichlorobenzene concentration (2.78 µg/m^3) is not shown directly on the box plot as the scale has been reduced to allow for the observation of data points at the lower end of the concentration range. In addition, the first and second quartiles for *p*-dichlorobenzene are zero and therefore not visible on the graph due to the large number of non-detects for this pollutant (more than 50 percent of the measurements are non-detects for *p*-dichlorobenzene). Twenty-three non-detects were measured at S4MO.

- While the maximum *p*-dichlorobenzene concentration measured across the program was not measured at S4MO, the second, third, fourth, fifth, and sixth highest concentrations of *p*-dichlorobenzene were measured at this site. The nine highest *p*-dichlorobenzene concentrations measured across the program (those greater than 0.75 µg/m^3) were split between S4MO and one other NMP site (NBIL). All four *p*-dichlorobenzene concentrations measured at S4MO were measured in 2016.

- Both annual average concentrations for S4MO are greater than the program-level average concentration (0.05 µg/m^3). This site has the third highest (2016) and sixth highest (2015) annual average concentrations of *p*-dichlorobenzene among NMP sites sampling VOCs.

Figure 15-10. Program vs. Site-Specific Average 1,2-Dichloroethane Concentrations

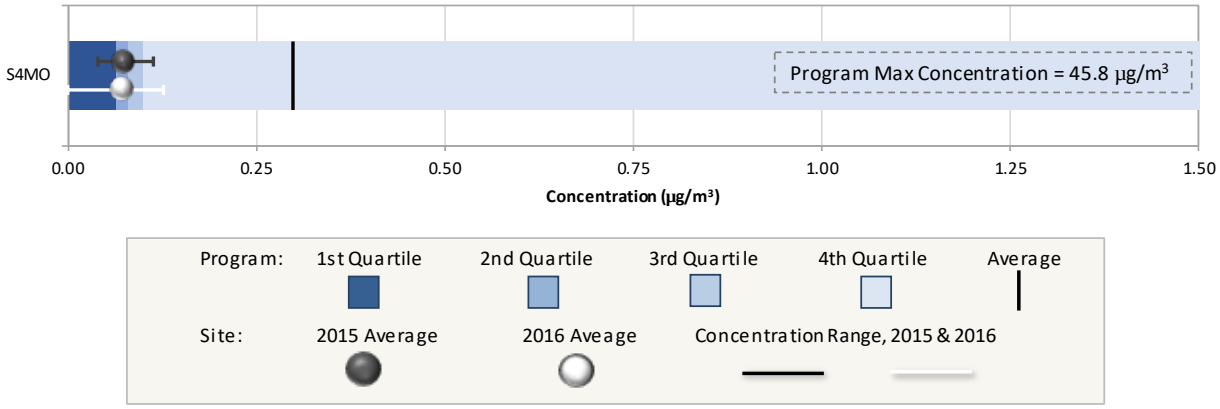


Figure 15-10 presents the box plot for 1,2-dichloroethane for S4MO and shows the following:

- The scale of the box plot in Figure 15-10 has also been reduced to allow for the observation of data points at the lower end of the concentration range, as the program-level maximum 1,2-dichloroethane concentration (45.8 µg/m^3) is considerably greater than the majority of measurements.

- All concentrations of 1,2-dichloroethane measured at S4MO are less than 0.15 µg/m^3, or half the program-level average concentration of 0.30 µg/m^3, which is being driven by the measurements at the upper end of the concentration range.

- The annual average concentrations for S4MO are both less than the program-level median concentration (0.081 µg/m^3).

Figure 15-11. Program vs. Site-Specific Average Ethylbenzene Concentrations

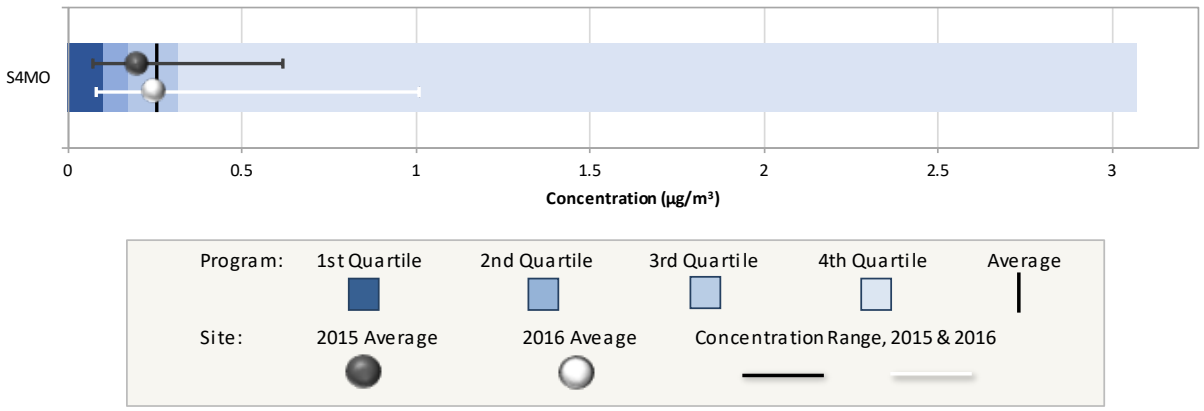


Figure 15-11 presents the box plot for ethylbenzene for S4MO and shows the following:

- A single ethylbenzene concentration greater than 1 µg/m^3 was measured at S4MO, which is about one-third the magnitude of the maximum ethylbenzene concentration measured across the program.

- The annual average concentrations of ethylbenzene for S4MO fall between the program-level median (0.17 µg/m^3) and average (0.26 µg/m^3) concentrations.

Figure 15-12. Program vs. Site-Specific Average Fluorene Concentrations

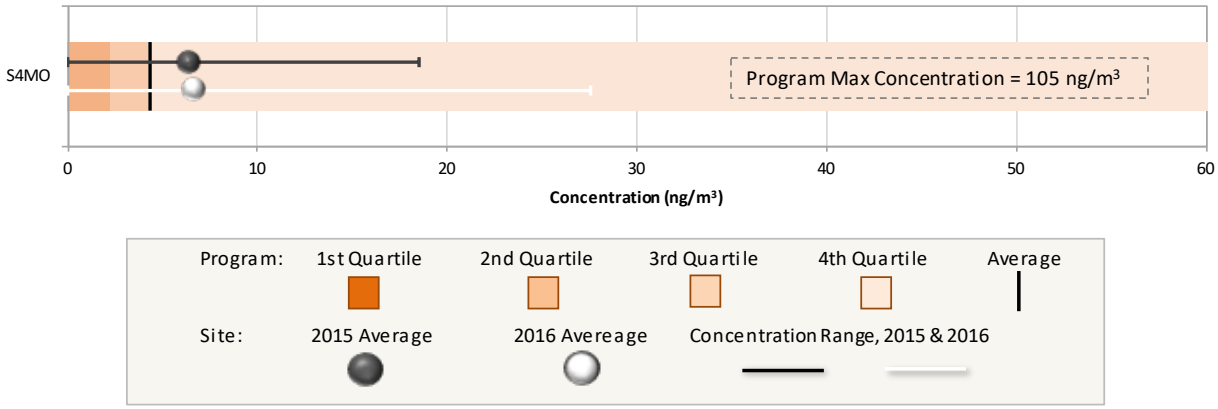


Figure 15-12 presents the box plot for fluorene for S4MO and shows the following:

- The program-level maximum fluorene concentration (105 ng/m^3) is not shown directly on the box plot in Figure 15-12 as the scale of the box plot has been reduced. Note that the first quartile is zero and therefore not visible on the box plot due to the number of non-detects.

- All of the fluorene concentrations measured at S4MO are considerably less than the maximum fluorene concentration measured across the program. Five fluorene

concentrations measured in 2016 are greater than the maximum fluorene concentration measured at S4MO in 2015 (18.5 ng/m^3). Yet, the annual average concentrations for both years are similar to each other and are greater than the program-level average concentration (4.36 ng/m^3).

- Eighteen non-detects of fluorene were measured at S4MO, accounting for 15 percent of the measurements, while non-detects account for 29 percent of the measurements at the program-level.

Figure 15-13. Program vs. Site-Specific Average Formaldehyde Concentrations

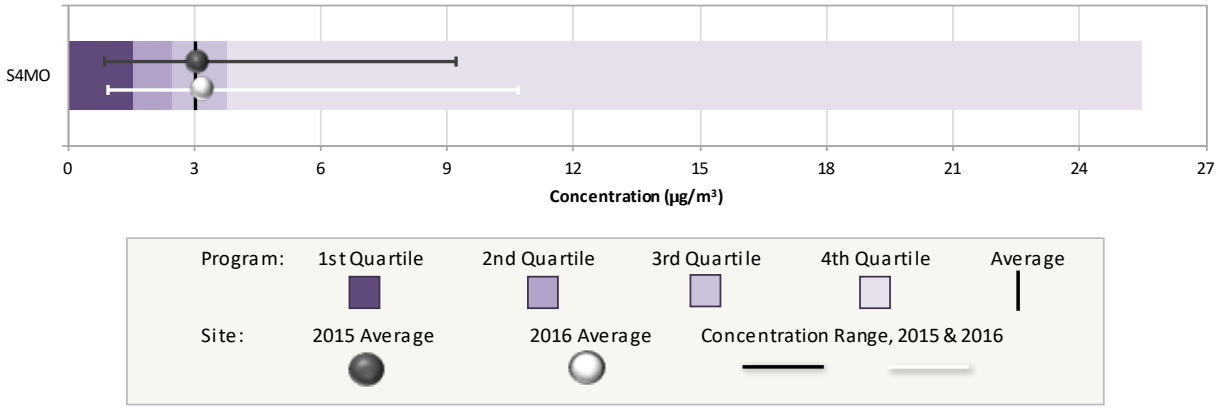


Figure 15-13 presents the box plot for formaldehyde for S4MO and shows the following:

- One formaldehyde concentration greater than 10 µg/m^3 was measured at S4MO; this concentration is less than half the maximum concentration measured across the program.

- The annual average concentrations of formaldehyde for S4MO are fairly similar to the program-level average concentration (3.05 µg/m^3), particularly 2015.

Figure 15-14. Program vs. Site-Specific Average Naphthalene Concentrations

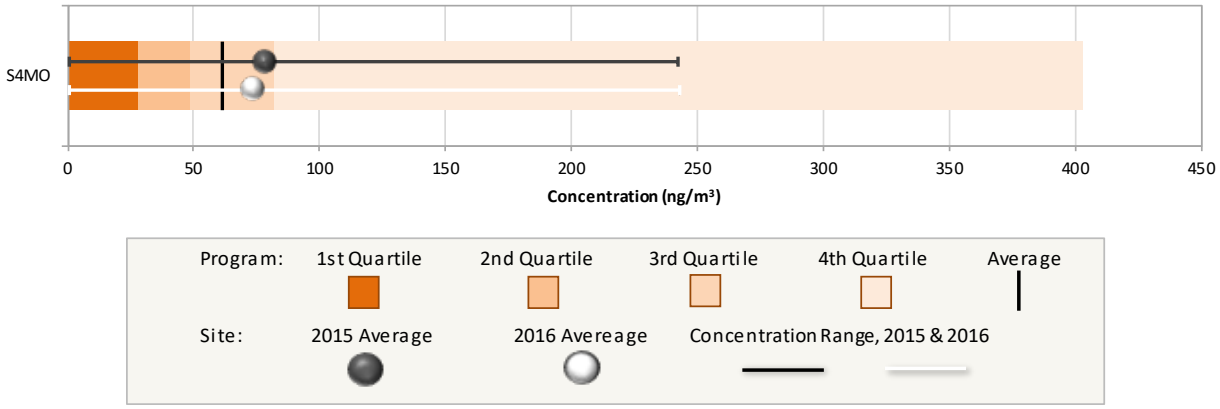


Figure 15-14 presents the box plot for naphthalene for S4MO and shows the following:

- Non-detects of naphthalene were not measured in 2015 or 2016, across the program or at S4MO, despite the low minimum concentrations shown on the box plot. As previously mentioned, some of the lowest concentrations of naphthalene across the program were measured at S4MO. This is an anomaly, for both this site and for the program.

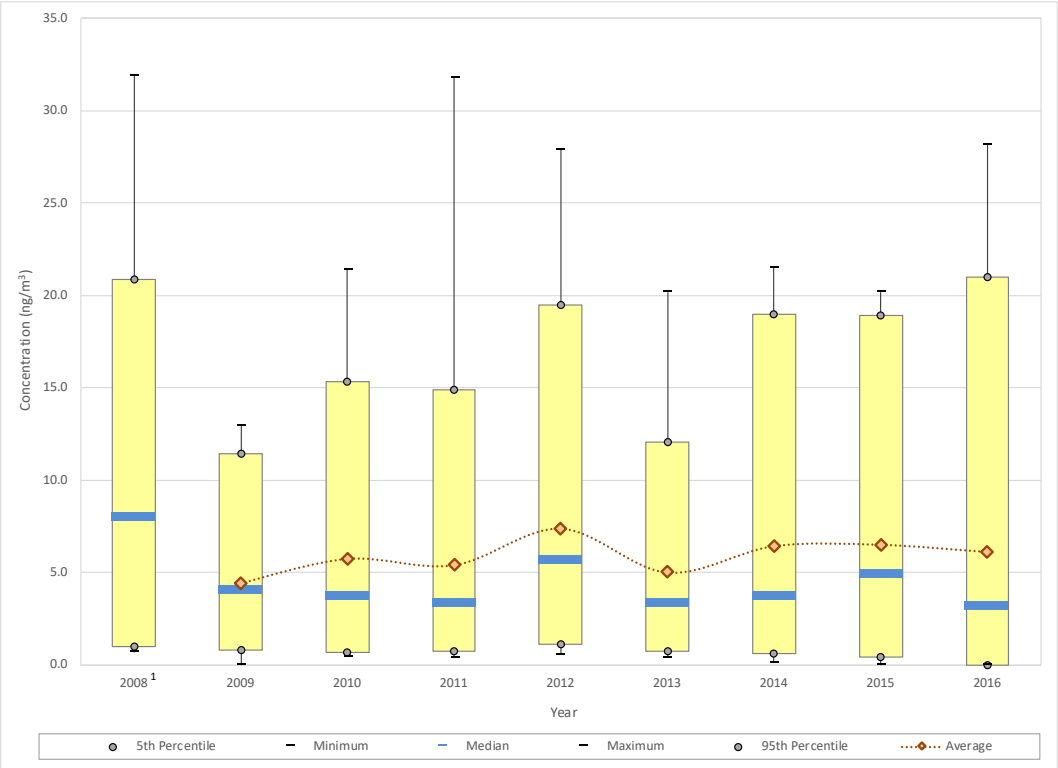
- The range of naphthalene concentrations measured at S4MO in 2015 is similar to the range of concentrations measured at this site in 2016.

- Both annual average concentrations of naphthalene for S4MO fall between the program-level average concentration (61.23 ng/m^3) and the program-level third quartile (82.15 ng/m^3).

15.3.3 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the pollutants of interest for 5 consecutive years or longer, as described in Section 3.4.2.2. S4MO has sampled VOCs and carbonyl compounds under the NMP since 2002, PM_{10} metals since 2003, and PAHs since 2008. Thus, Figures 15-15 through 15-26 present the 1-year statistical metrics for each of the pollutants of interest for S4MO. The statistical metrics presented for assessing trends include the substitution of zeros for non-detects. If sampling began mid-year, a minimum of 6 months of sampling is required for inclusion in the trends analysis; in these cases, a 1-year average concentration is not provided, although the range and percentiles are still presented.

Figure 15-15. Yearly Statistical Metrics for Acenaphthene Concentrations Measured at S4MO



[1] A 1-year average is not presented because sampling under the NMP did not begin until April 2008.

Observations from Figure 15-15 for acenaphthene concentrations measured at S4MO include the following:

- S4MO began sampling PAHs under the NMP in April 2008. Because a full year's worth of data is not available, a 1-year average concentration for 2008 is not presented, although the range of measurements is provided.

- Three measurements greater than 30 ng/m^3 have been measured at S4MO, two in September 2008 and another in July 2011.

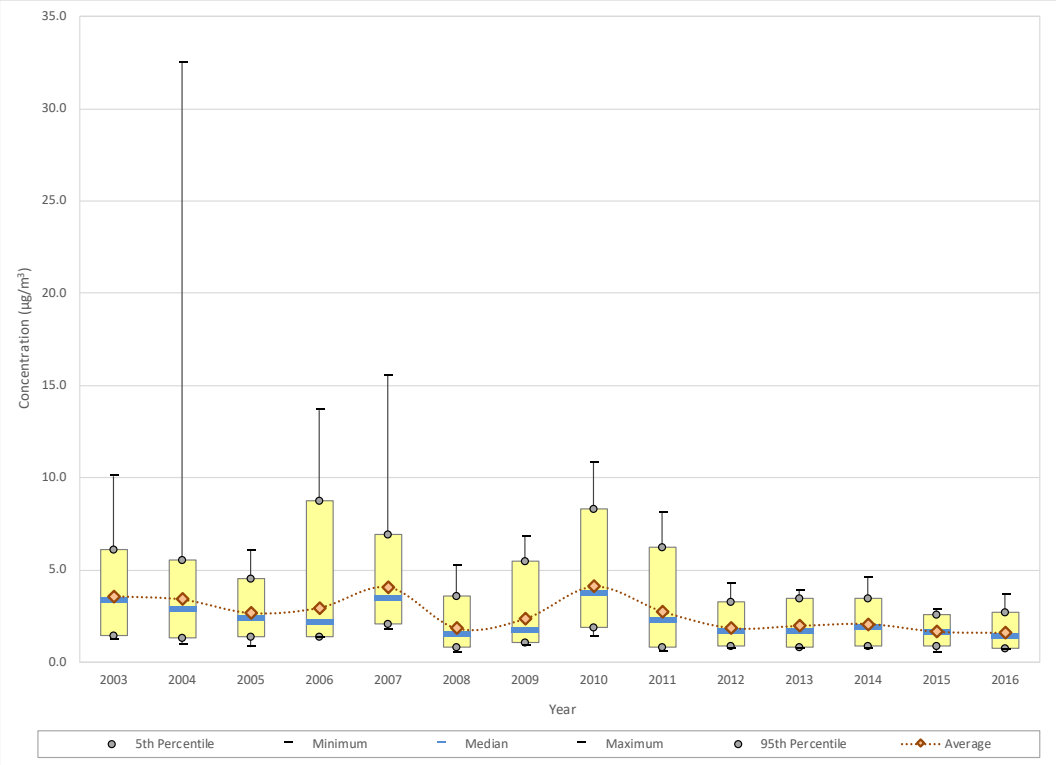
- All of the statistical parameters shown exhibit decreases from 2008 to 2009. In all, 11 concentrations measured in 2008 are greater than the maximum concentration measured in 2009. In addition, acenaphthene concentrations less than 5 ng/m^3 accounted for more than twice the percentage of samples collected in 2009 (64 percent) compared to 2008 (32 percent).

- Although the range of concentrations measured increased from 2009 to 2010 and again for 2011, the median concentration decreased slightly each year.

- Between 2011 and 2014, the 1-year average concentration has a fluctuating pattern, as years with lower averages alternate with years with higher averages. The median concentration has a similar pattern, although the increase shown for 2014 is smaller than the increase shown in the 1-year average concentration.

- Little change in the 1-year average concentration is shown between 2014 and 2016, despite an increasing number of non-detects (from none, to three, to eight over the 3-year period) and fluctuations in the magnitude of concentrations measured, predominantly at the lower end of the concentration range, though a few higher concentrations were also measured in 2016.

Figure 15-16. Yearly Statistical Metrics for Acetaldehyde Concentrations Measured at S4MO



Observations from Figure 15-16 for acetaldehyde concentrations measured at S4MO include the following:

- Because carbonyl compound sampling under the NMP did not begin at S4MO until December 2002, data from 2002 were excluded from this analysis.

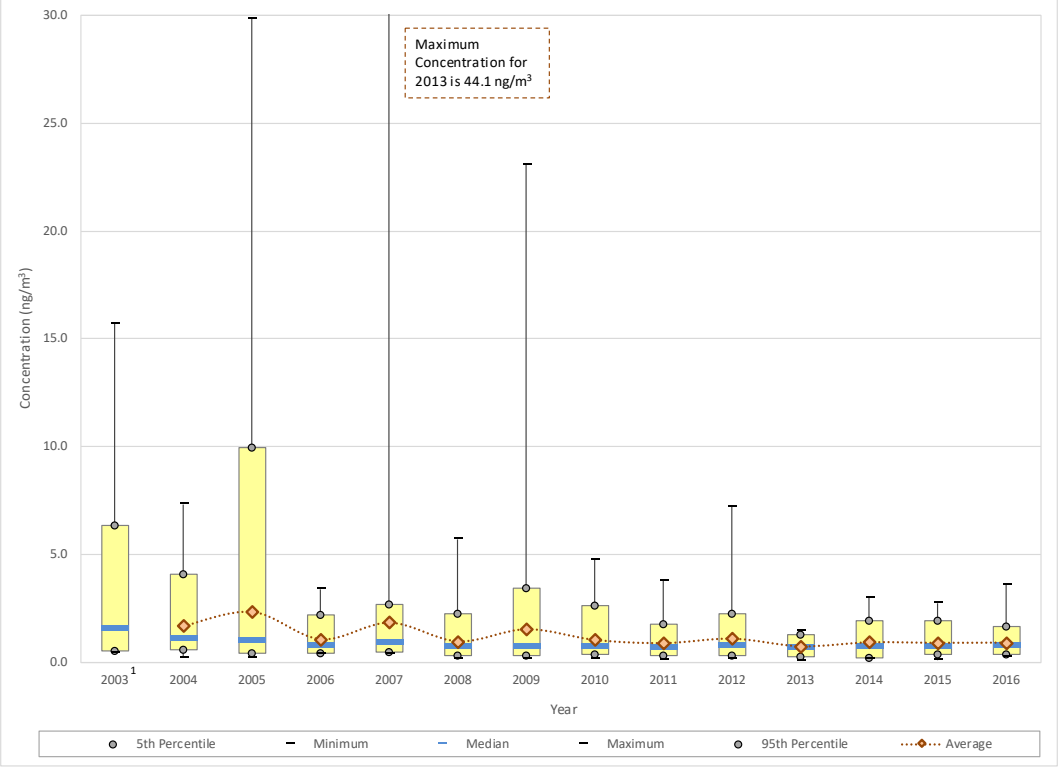
- The maximum acetaldehyde concentration was measured in 2004 (32.5 µg/m^3) and is more than twice the next highest concentration (15.5 µg/m^3, measured in 2007).

- Even with the maximum concentration measured in 2004, nearly all of the statistical parameters decreased from 2003 to 2004. The maximum concentration measured in 2004 is nearly six times higher than the next highest concentration measured that year (5.72 µg/m^3). Excluding the outlier, five concentrations measured in 2003 are higher than the second highest concentration measured in 2004. At the other end of the concentration range, the number of acetaldehyde concentrations less than 3 µg/m^3 increased from 22 to 34, and thus, accounted for more than half of the measurements in 2004. Additional decreases are shown for 2005.

- Between 2003 and 2012, the 1-year average concentrations have an undulating pattern, with a few years of a decreasing trend followed by a few years of an increasing trend. During this time, the 1-year average concentrations varied between 1.83 µg/m^3 (2008) and 4.10 µg/m^3 (2010).

- After the significant decrease shown between 2010 and 2012, the changes shown are more subtle in nature. The concentrations measured during the 3-year period from 2012 to 2014 exhibit the least year-to-year variability in concentrations measured since the onset of sampling. Additional decreases are shown after 2014, with several of the parameters at a minimum for 2016, including both the 1-year average and median concentrations. The median concentration for 2016 is less than 1.50 µg/m^3 for the first time since the onset of sampling.

Figure 15-17. Yearly Statistical Metrics for Arsenic (PM_{10}) Concentrations Measured at S4MO



[1] A 1-year average is not presented because sampling under the NMP did not begin until July 2003.

Observations from Figure 15-17 for arsenic concentrations measured at S4MO include the following:

- S4MO began sampling metals under the NMP in July 2003. Because a full year's worth of data is not available, a 1-year average concentration is not presented, although the range of measurements is provided.

- The maximum arsenic concentration was measured at S4MO on December 26, 2007 (44.1 ng/m^3). Five additional arsenic concentrations greater than 10 ng/m^3 have been measured at S4MO (three in 2005 and one each in 2003 and 2009).

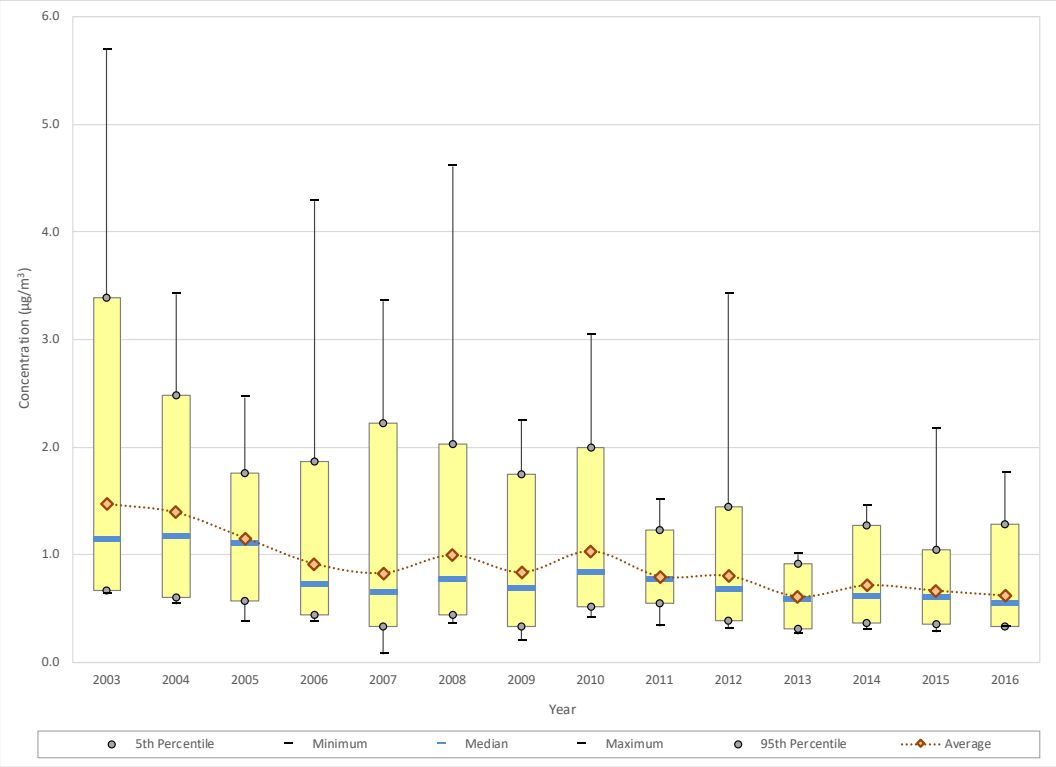
- This figure shows that years with little variability in the measurements alternate with years with significant variability, particularly between 2004 and 2010. Less measurement variability is shown in the years that follow.

- Most of the statistical parameters are at a minimum for 2013. The range of measurements, the difference between the 5th and 95th percentiles, and the difference between the median and 1-year average concentrations are also at a minimum for 2013.

- With the exception of the 5th percentile, increases are shown for each of the parameters for 2014, although some are slight (the median increased by less than 0.1 ng/m^3) while others are relatively large (the maximum concentration doubled from 2013 to 2014).

- Despite a few changes in concentrations at the upper and/or lower end of the concentration range, relatively little change is shown in the central tendency parameters between 2014 and 2016.

Figure 15-18. Yearly Statistical Metrics for Benzene Concentrations Measured at S4MO



Observations from Figure 15-18 for benzene concentrations measured at S4MO include the following:

- Because VOC sampling under the NMP did not begin at S4MO until December 2002, 2002 data was excluded from this analysis.

- One benzene concentration greater than 5 µg/m^3 has been measured at S4MO (2003). Three additional benzene concentrations greater than 4 µg/m^3 have also been measured (one each in 2003, 2006, and 2008).

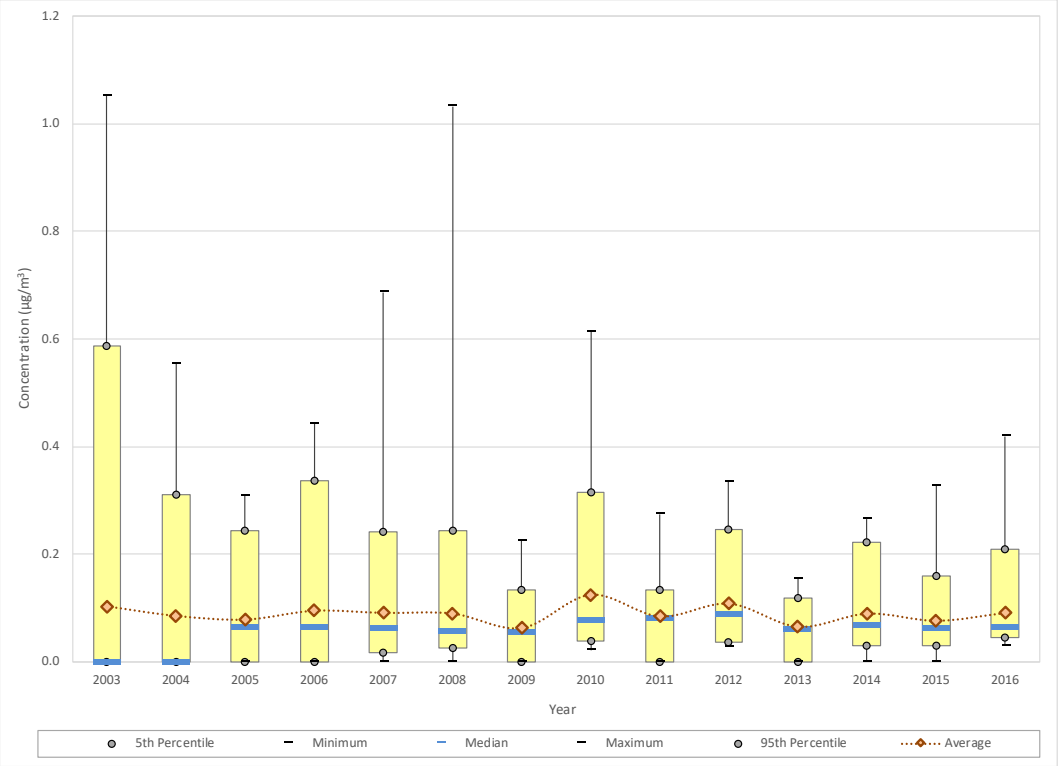
- The 1-year average concentration exhibits a steady decreasing trend through 2007, representing a 44 percent decrease. In the years between 2007 and 2011, the 1-year average concentrations have a slight undulating pattern, with the 1-year average varying between 0.80 µg/m^3 (2011) and 1.03 µg/m^3 (2010).

- From 2011 to 2012, the statistical parameters representing the upper end of the concentration range (the maximum and 95th percentile) increased while the statistical parameters representing the lower end of the concentration range (the minimum and 5th percentile) decreased, indicating a widening of concentrations measured. Yet, the 1-year average concentration did not change and the median decreased. The number of concentrations greater than 1 µg/m^3 doubled (from six in 2011 to 12 in 2012) while the number of concentrations less than 0.5 µg/m^3 increased from two in 2011 to 12 in 2012.

- Several of the statistical parameters are at a minimum for 2013, including the 1-year average concentration (0.61 µg/m^3), when a single benzene concentration greater than 1 µg/m^3 was measured.

- All of the statistical parameters exhibit slight increases for 2014. Despite a few changes at the upper end of the concentration range, the central tendency parameters both exhibit additional decreases for 2015 and 2016, with the median concentration at a minimum for 2016.

Figure 15-19. Yearly Statistical Metrics for 1,3-Butadiene Concentrations Measured at S4MO



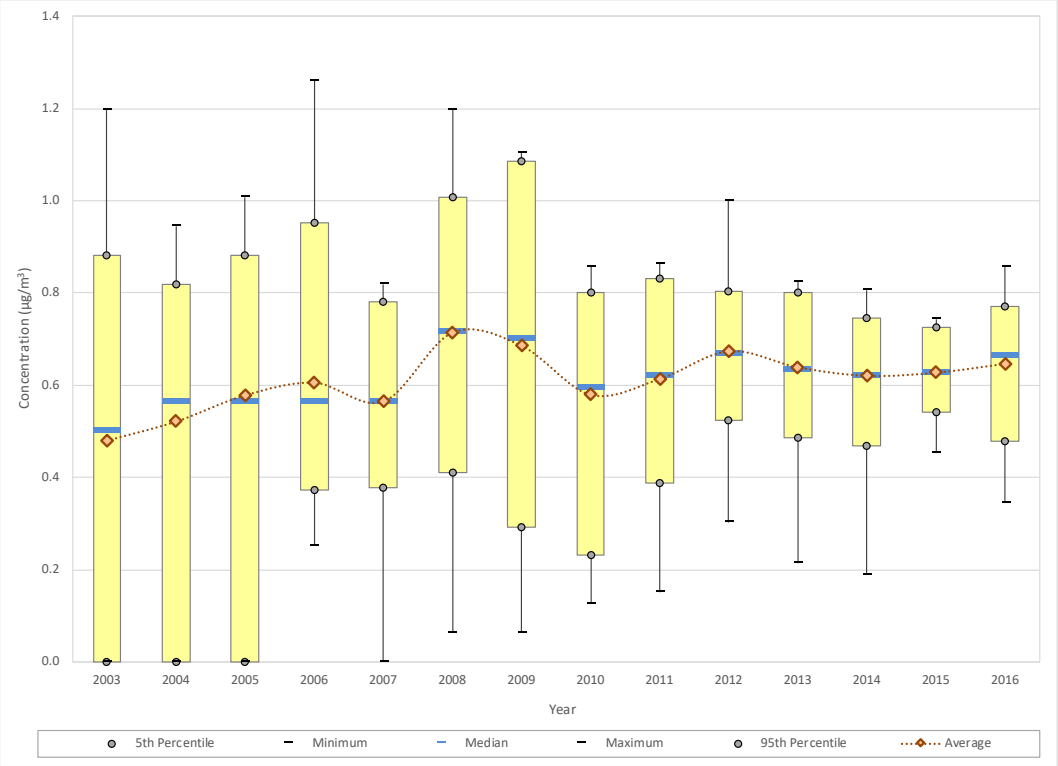
Observations from Figure 15-19 for 1,3-butadiene concentrations measured at S4MO include the following:

- The maximum 1,3-butadiene concentration was measured at S4MO in 2003, although a similar concentration was also measured in 2008. These are the only two 1,3-butadiene concentrations greater than 1.0 µg/m^3 that have been measured at S4MO.

- The minimum, 5th percentile, and median concentrations are all zero for 2003 and 2004, indicating that at least 50 percent of the measurements were non-detects. The number of non-detects decreased after 2004, from a maximum of 43 non-detects in 2004 to a minimum of zero in 2010 (also 2012 and 2016). After 2006, no more than five non-detects of 1,3-butadiene have been measured at S4MO in any given year.

- Between 2004 and 2008, the 1-year average concentration changed little, ranging from 0.079 µg/m^3 (2005) to 0.095 µg/m^3 (2006). Greater fluctuations are shown in the years that follow. Years with a higher number of non-detects, as indicated by a minimum and 5th percentile of zero, such as 2009, 2011, and 2013, alternate with years without any non-detects (2010 and 2012) and concentrations that are higher in magnitude, as indicated by the 95th percentile and maximum concentration. This pattern ends with 2014, as two non-detects were measured in 2014, but the undulating pattern in the 1-year average concentration continues.

Figure 15-20. Yearly Statistical Metrics for Carbon Tetrachloride Concentrations Measured at S4MO



Observations from Figure 15-20 for carbon tetrachloride concentrations measured at S4MO include the following:

- Twenty of the 21 non-detects of carbon tetrachloride were measured at S4MO in 2003, 2004, or 2005, with a single non-detect measured in 2007.

- A steady increasing trend in the 1-year average concentration is shown through 2006. Although the maximum concentration decreased substantially from 2006 to 2007 and a non-detect was measured, the decrease in the 1-year average concentration is not statistically significant and the median concentration did not change at all. In fact, the median concentration is steady at 0.57 µg/m^3 between 2004 and 2007.

- All of the statistical parameters exhibit increases from 2007 to 2008. Twenty concentrations, or nearly one-third of the concentrations, measured in 2008 are greater than the maximum concentration measured in 2007.

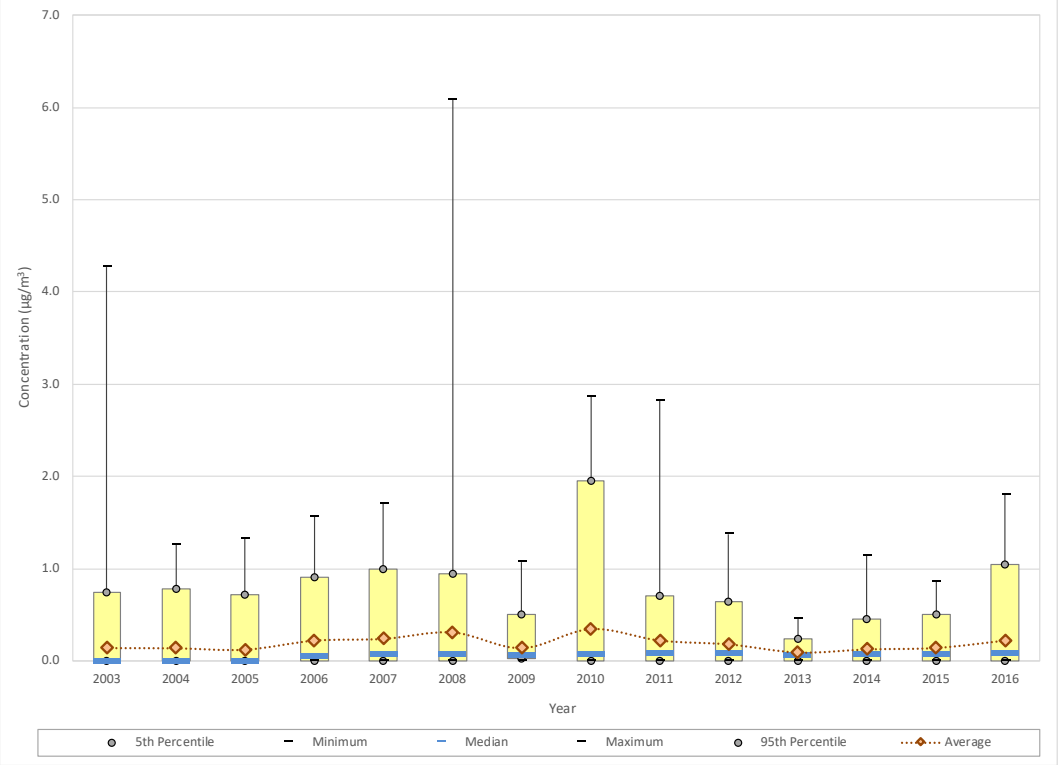
- Both the median and 1-year average concentrations have a decreasing trend between 2008 and 2010, with 1-year average concentration returning to near 2007 levels.

- Between 2010 and 2012, the 1-year average concentration has a significant increasing trend even as the majority of concentrations measured are falling into a tighter range, as indicated by the decreasing difference between the 5th and 95th percentiles for these years.

- Nearly all of the statistical parameters exhibit decreases for 2013 and again for 2014. A larger number of concentrations at the lower end of the concentration range was measured each year, while fewer concentrations at the upper end of the concentration range were measured. The number of concentrations less than 0.65 µg/m^3 increased between 2012 and 2014, from 20 in 2012 to 34 in 2013 and 35 in 2014. At the other end of the concentration range, fewer concentrations greater than 0.8 µg/m^3 have been measured each year, with the fewest measured in 2014 (one).

- The tightest range of carbon tetrachloride concentrations was measured at S4MO in 2015, with less than 0.3 µg/m^3 separating the minimum and maximum concentrations measured. The concentration profile widens for 2016, though. Even though 1-year average concentration exhibits an increase from 2015 to 2016, the change is not statistically significant. In fact, less than 0.03 µg/m^3 separates the 1-year average concentrations between 2013 and 2016.

Figure 15-21. Yearly Statistical Metrics for *p*-Dichlorobenzene Concentrations Measured at S4MO



Observations from Figure 15-21 for *p*-dichlorobenzene concentrations measured at S4MO include the following:

- The minimum, 5th percentile, and median concentrations are all zero for 2003, 2004, and 2005, indicating that at least 50 percent of the measurements were non-detects. The percentage of non-detects was at a maximum in 2003 (90 percent), after which the percentage decreased, reaching a minimum of 5 percent for 2009. The percentage of non-detects varies between 10 percent (2012) and 25 percent (2014) each year following 2009.

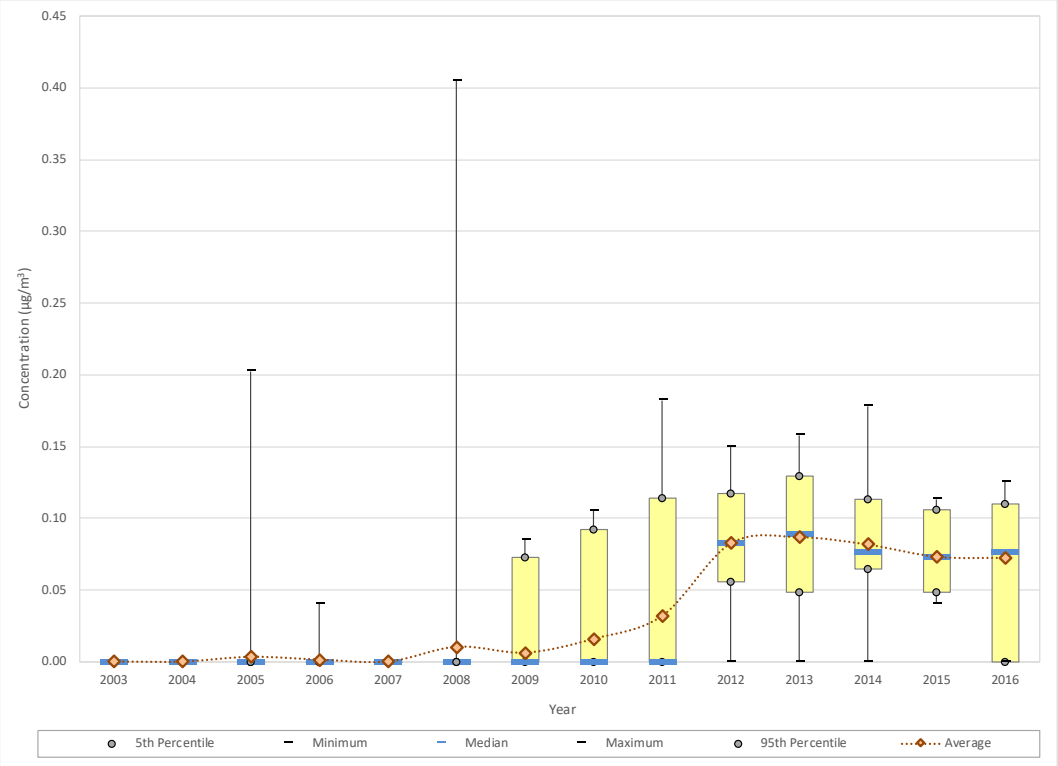
- After little change in the early years, the 1-year average and median concentrations increased steadily between 2005 and 2008. However, the relatively large number of non-detects (zeros) combined with the range of measured detections result in a relatively high level of variability, based on the confidence intervals calculated for the 1-year averages. This is particularly true for 2008, when the maximum *p*-dichlorobenzene concentration was measured (6.08 $\mu g/m^3$). If the maximum concentration for 2008 was excluded from the dataset, the concentration profile for 2008 would more closely resemble the concentration profile for 2007.

- The concentrations measured decreased considerably from 2008 to 2009 then increased again in 2010. The 95th percentile decreased by almost half from 2008 to 2009, then increased by a factor of four for 2010. The number of concentrations greater than 1 $\mu g/m^3$ decreased from three in 2008 to one in 2009, then increased to six for 2010, which is the most across the years of sampling. At the same time, the number of non-detects decreased from eight in 2008 to three 2009, then returned to eight in 2010.

- Although the range of concentrations measured in 2011 is similar to the range of concentrations measured in 2010, the 95th percentile and 1-year average concentration decreased considerably. Further decreases are shown for these parameters for 2012 and again for 2013. Several of the statistical parameters are at a minimum for 2013, including the 1-year average concentration, which is less than 0.1 $\mu g/m^3$ for the first time. This year has the smallest range of concentrations measured by a considerable margin.

- Several of the statistical parameters exhibit increases each year after 2013, including the 95th percentile, which in 2016 is greater than 1 $\mu g/m^3$ for the first time since 2010, and the 1-year average concentration, which in 2016 is greater than 0.2 $\mu g/m^3$ for the first time in five years.

Figure 15-22. Yearly Statistical Metrics for 1,2-Dichloroethane Concentrations Measured at S4MO



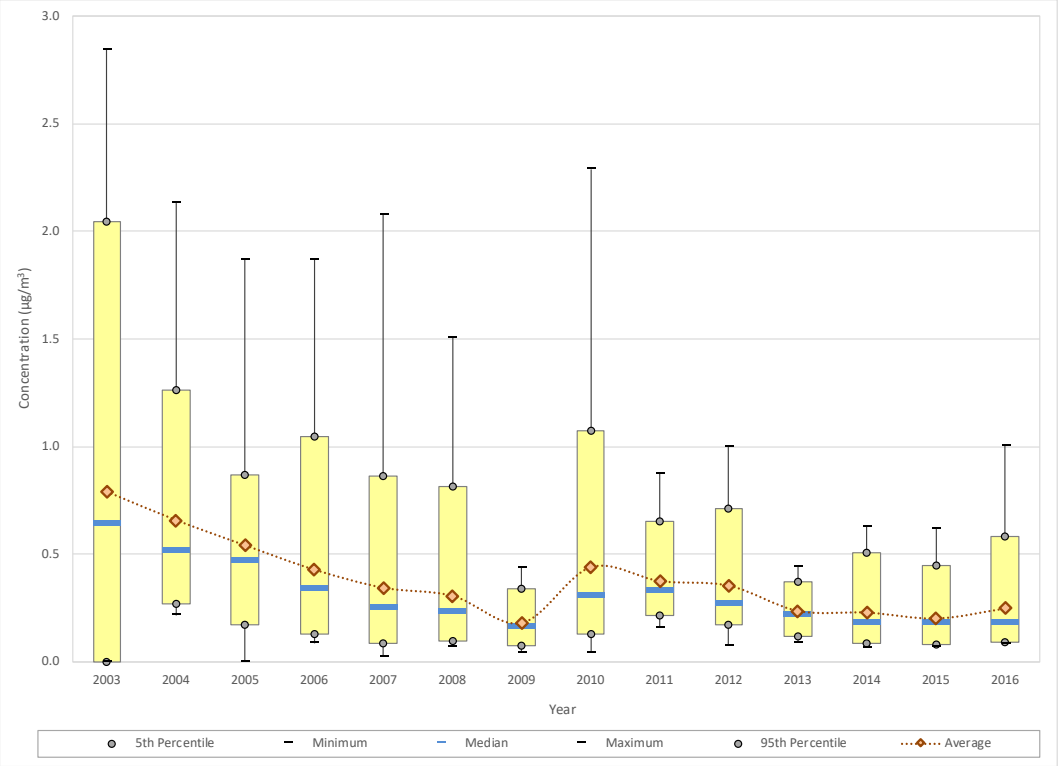
Observations from Figure 15-22 for 1,2-dichloroethane concentrations measured at S4MO include the following:

- The minimum, 5th percentile, and median concentrations are all zero through 2011, indicating that at least 50 percent of the measurements were non-detects. There were no measured detections of 1,2-dichloroethane in 2003, 2004, or 2007, one measured detection in 2005, and two each in 2006 and 2008. The number of measured detections increased steadily afterward, reaching a maximum of 60 for 2015, when non-detects were not measured. Non-detects accounted for 10 percent of the measurements in 2016, the most since 2011.

- As the number of measured detections increased in the later years of sampling, each of the corresponding statistical metrics also increased. The 5th percentile and median concentrations are greater than zero beginning with 2012, when measured detections accounted for a majority of the measurements for the first time. The central tendency parameters are both at a maximum for 2013, when they both are approximately 0.09 µg/m^3.

- The 1-year average concentration decreases slightly each year after 2013, although the change over the 4-year period is less than 0.015 µg/m^3.

Figure 15-23. Yearly Statistical Metrics for Ethylbenzene Concentrations Measured at S4MO



Observations from Figure 15-23 for ethylbenzene concentrations measured at S4MO include the following:

- Both ethylbenzene concentrations greater than 2.5 µg/m^3 were measured at S4MO in 2003 (2.85 µg/m^3 and 2.63 µg/m^3). Most of the 18 ethylbenzene concentrations greater than 1.5 µg/m^3 were measured in 2008 or earlier, with two exceptions measured in 2010.

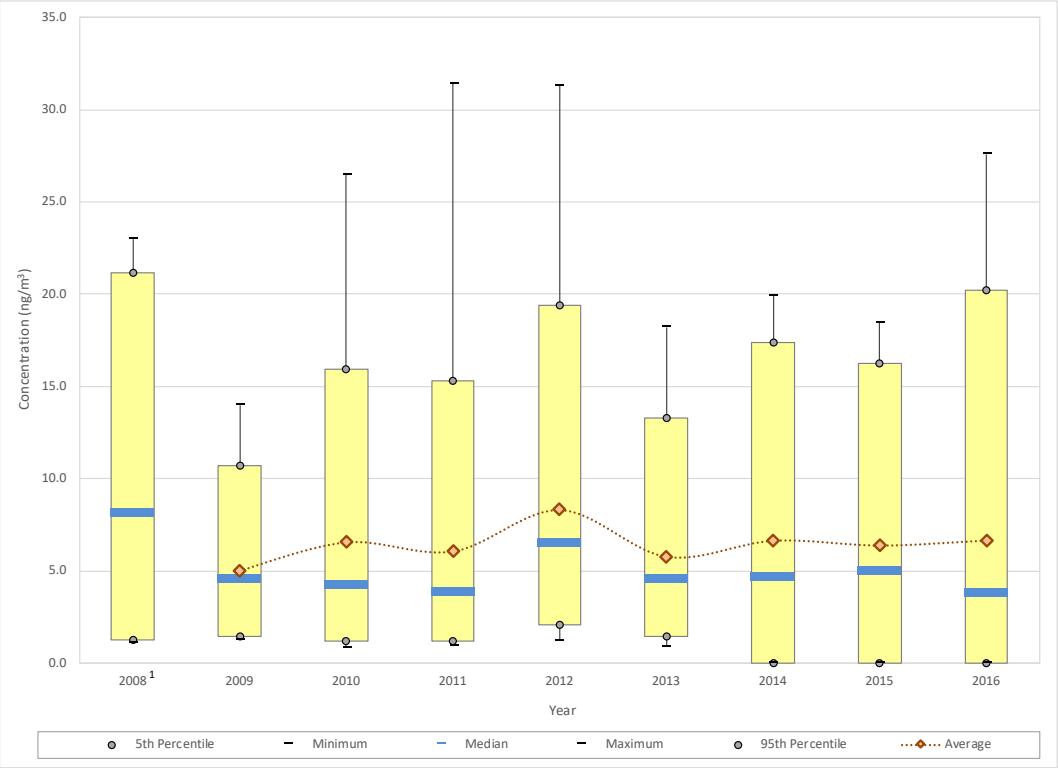
- Concentrations of ethylbenzene exhibit a significant decreasing trend between 2003 and 2009, when most of the statistical parameters are a minimum.

- With the exception of the minimum concentration, all of the statistical parameters exhibit increases for 2010, in some cases doubling (1-year average and median), tripling (95th percentile) or increasing by an even higher amount (maximum). The 1-year average concentration for 2010 is nearly equivalent to the maximum concentration measured in 2009. Fifteen concentrations measured in 2010 are greater than the maximum concentration measured in 2009.

- A steady decreasing trend in the ethylbenzene concentrations measured at S4MO is shown again after 2010. The 1-year average concentration decreases by more than half between 2010 and 2015.

- All of the statistical parameters exhibit slight increases for 2016.

Figure 15-24. Yearly Statistical Metrics for Fluorene Concentrations Measured at S4MO



[1] A 1-year average is not presented because sampling under the NMP did not begin until April 2008.

Observations from Figure 15-24 for fluorene concentrations measured at S4MO include the following:

- The box and whisker plots for fluorene measurements resemble the plots for acenaphthene presented in Figure 15-15.

- Two concentrations greater than 30 ng/m^3 have been measured at S4MO, one on July 2, 2011 (31.4 ng/m^3) and one on July 2, 2012 (31.3 ng/m^3). The highest fluorene concentrations tended to be measured during the warmer months of the year. Of the 48 fluorene concentrations greater than 15 ng/m^3, 35 were measured at S4MO between June and August of any given year and none were measured in January, February, March, or December.

- Despite fluctuations in the measurements at the upper end of the concentration scale and little change at lower end of the concentration scale, the median concentration decreases each year through 2011, with the largest change shown between 2008 and 2009. The percentage of fluorene concentrations less than 5 ng/m^3 nearly doubled over this 4-year period, accounting for 32 percent of the measurements in 2008 and more than 60 percent of the measurements in 2011.

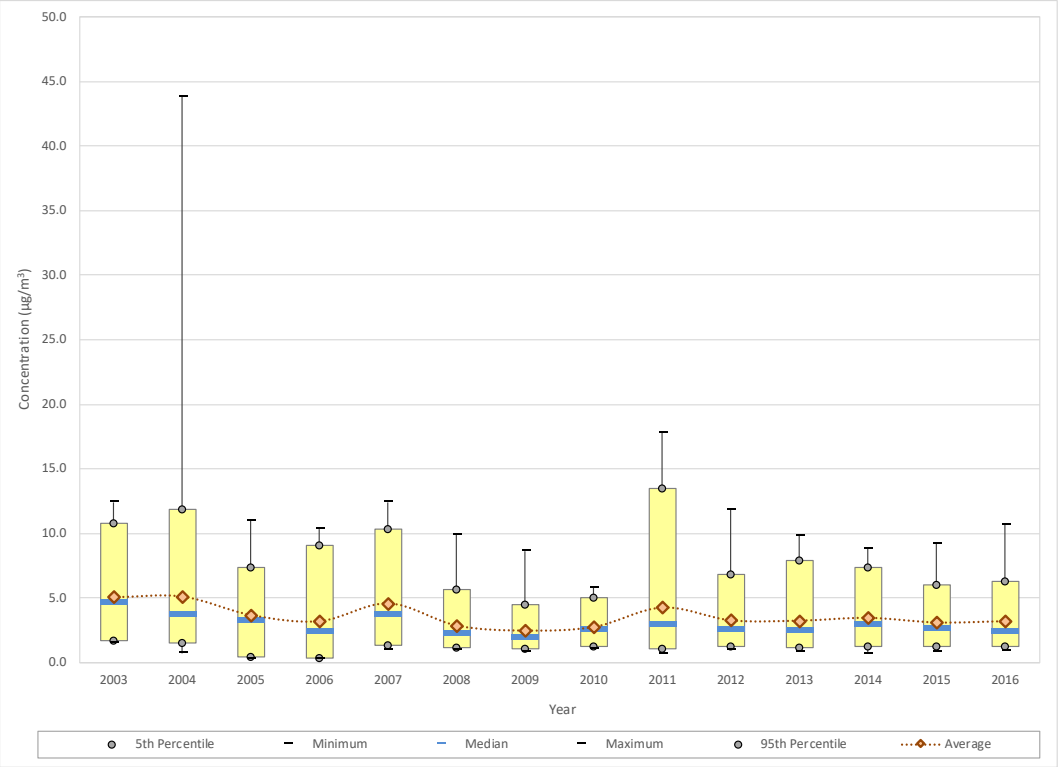
- With the exception of the maximum concentration, which virtually did not change, the statistical parameters exhibit increases from 2011 to 2012. This is because the number of measurements at the upper end of the range increased while the number of measurements at the lower end of the concentration range decreased. The number of

concentrations greater than 10 ng/m^3 increased from 13 in 2011 to 22 in 2012; conversely, the number of concentrations less than 2 ng/m^3 decreased from 11 in 2011 to three in 2012.

- All of the statistical parameters exhibit decreases for 2013.

- The first non-detects (four) of fluorene were measured at S4MO in 2014, as indicated by the minimum and 5th percentile decreasing to zero. The number of non-detects increased to five in 2015 and 13 in 2016, accounting for more than one-fifth of the measurements in 2016. During this 3-year period, little change is shown in the 1-year average concentrations of fluorene.

Figure 15-25. Yearly Statistical Metrics for Formaldehyde Concentrations Measured at S4MO



Observations from Figure 15-25 for formaldehyde concentrations measured at S4MO include the following:

- The maximum formaldehyde concentration (43.8 µg/m^3) was measured in 2004 on the same day that the maximum acetaldehyde concentration was measured (August 31, 2004). This concentration is more than twice the next highest concentration (17.8 µg/m^3), which was measured in 2011. The six highest concentrations of formaldehyde were measured in 2004 (2) or 2011 (4).

- The 1-year average concentration has a decreasing trend between 2004 and 2006. After the increase shown for 2007, the decreasing trend resumed through 2009, when the 1-year average was at a minimum (2.46 µg/m^3). The 1-year average concentration

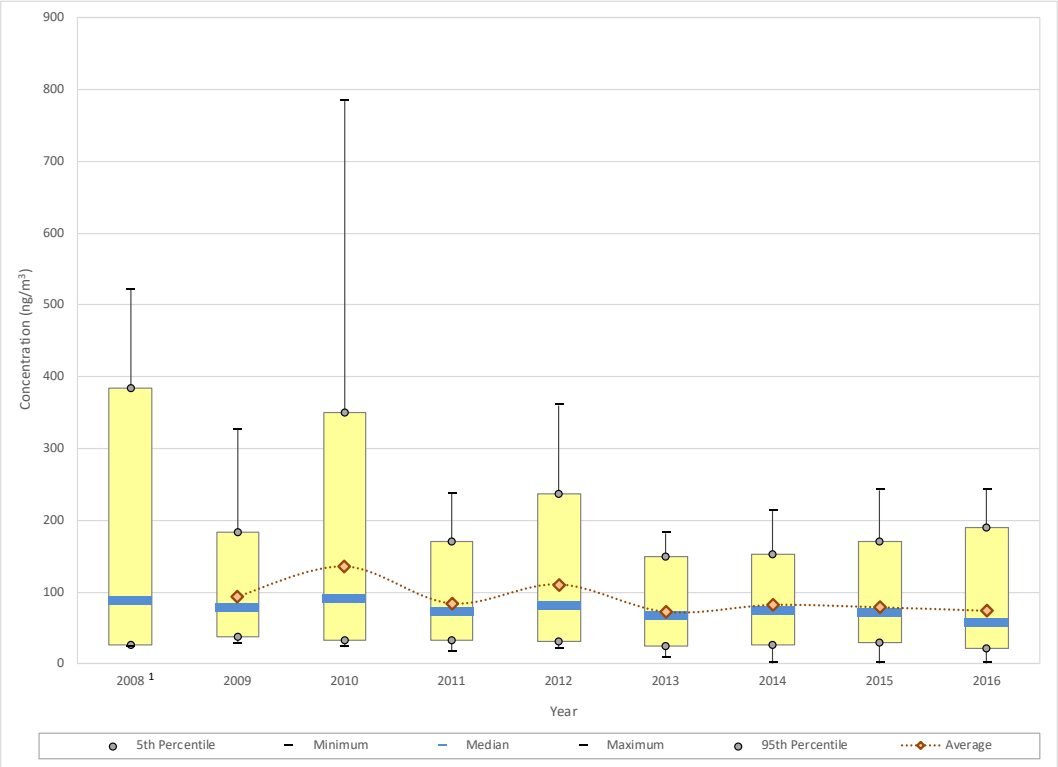
did not change significantly between 2009 and 2010, even though the smallest range of concentrations was measured in 2010.

- Most of the statistical parameters exhibit considerable increases from 2010 to 2011. Eleven concentrations of formaldehyde measured in 2011 are greater than the maximum concentration measured in 2010.

- Most of the statistical parameters exhibit decreases from 2011 to 2012.

- The central tendency statistics exhibit little change between 2012 and 2016.

Figure 15-26. Yearly Statistical Metrics for Naphthalene Concentrations Measured at S4MO



[1] A 1-year average is not presented because sampling under the NMP did not begin until April 2008.

Observations from Figure 15-26 for naphthalene concentrations measured at S4MO include the following:

- Naphthalene concentrations measured at S4MO exhibit considerable variability, spanning three orders of magnitude and ranging from 0.660 ng/m^3 (2016) to 784 ng/m^3 (2010). Naphthalene concentrations less than 10 ng/m^3 have only been measured in 2014, 2015, and 2016.

- The years when relatively high concentrations were measured alternate with years when the highest concentrations are considerably less, resulting in the 1-year average (and median) concentrations having an undulating pattern. The difference decreases, though, in the later years of sampling.

15.4 Additional Risk-Based Screening Evaluations

The following risk-based screening evaluations were conducted to characterize risk related to the air toxics measured at the S4MO monitoring site. Refer to Sections 3.2, 3.4.2.3, and 3.4.2.4 for definitions and explanations regarding the various toxicity factors, time frames, and calculations associated with these risk-based screenings.

15.4.1 Cancer Risk and Noncancer Hazard Approximations

For the pollutants of interest for S4MO, risk was examined by calculating cancer risk and noncancer hazard approximations for each year annual average concentrations could be calculated. These approximations can be used as risk estimates for cancer and noncancer effects attributable to the pollutants of interest. Although the use of these approximations is limited, they may help identify where policy-makers want to shift their air monitoring priorities. Refer to Section 3.4.2.3 for an explanation of how cancer risk and noncancer hazard approximations are calculated and what limitations are associated with them. Annual averages, cancer UREs and/or noncancer RfCs, and cancer risk and noncancer hazard approximations are presented in Table 15-4, where applicable. Cancer risk approximations are presented as probabilities while the noncancer hazard approximations are ratios and thus, unitless values.

Observations for S4MO from Table 15-4 include the following:

- The pollutants with the highest annual average concentrations for S4MO are formaldehyde and acetaldehyde; these are the only pollutants of interest with annual average concentrations greater than 1 $\mu g/m^3$.

- Formaldehyde has the highest cancer risk approximations for S4MO (40.19 in-a-million for 2015 and 41.49 in-a-million for 2016). Formaldehyde's cancer risk approximations are at least an order of magnitude higher than the cancer risk approximations for the other pollutants of interest. Benzene has the next highest cancer risk approximations for S4MO (5.17 in-a-million for 2015 and 4.81 in-a-million for 2016).

- None of the pollutants of interest for S4MO have noncancer hazard approximations greater than 1.0, indicating that no adverse noncancer health effects are expected from these individual pollutants. The pollutant with the highest noncancer hazard approximations is formaldehyde (0.32 for 2015 and 0.33 for 2016).

Table 15-4. Risk Approximations for the Missouri Monitoring Site

Pollutant	Cancer URE ($\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	2015				2016			
			# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Risk Approximations		# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Risk Approximations	
					Cancer (in-a-million)	Noncancer (HQ)			Cancer (in-a-million)	Noncancer (HQ)
St. Louis, Missouri - S4MO										
Acetaldehyde	0.0000022	0.009	60/60	1.66 ± 0.14	3.65	0.18	60/60	1.59 ± 0.16	3.51	0.18
Benzene	0.0000078	0.03	60/60	0.66 ± 0.08	5.17	0.02	60/60	0.62 ± 0.07	4.81	0.02
1,3-Butadiene	0.00003	0.002	59/60	0.08 ± 0.01	2.30	0.04	60/60	0.09 ± 0.02	2.73	0.05
Carbon Tetrachloride	0.000006	0.1	60/60	0.63 ± 0.02	3.77	0.01	60/60	0.65 ± 0.02	3.88	0.01
p-Dichlorobenzene	0.000011	0.8	49/60	0.14 ± 0.04	1.57	<0.01	48/60	0.22 ± 0.10	2.44	<0.01
1,2-Dichloroethane	0.000026	2.4	60/60	0.07 ± <0.01	1.91	<0.01	54/60	0.07 ± 0.01	1.89	<0.01
Ethylbenzene	0.0000025	1	60/60	0.20 ± 0.03	0.51	<0.01	60/60	0.25 ± 0.05	0.62	<0.01
Formaldehyde	0.000013	0.0098	60/60	3.09 ± 0.42	40.19	0.32	60/60	3.19 ± 0.48	41.49	0.33
Acenaphthene[a]	0.000088	--	55/58	6.51 ± 1.47	0.57	--	52/60	6.13 ± 1.71	0.54	--
Arsenic (PM_{10})[a]	0.0043	0.000015	60/60	0.88 ± 0.12	3.77	0.06	61/61	0.90 ± 0.13	3.86	0.06
Fluorene[a]	0.000088	--	53/58	6.40 ± 1.31	0.56	--	47/60	6.67 ± 1.81	0.59	--
Naphthalene[a]	0.000034	0.003	58/58	78.32 ± 11.77	2.66	0.03	60/60	73.48 ± 14.07	2.50	0.02

-- = A Cancer URE or Noncancer RfC is not available.

[a] Average concentrations provided below the blue line for this pollutant are presented in ng/m^3 for ease of viewing.

15.4.2 Risk-Based Emissions Assessment

In addition to the risk-based screening discussed above, this section presents an evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 15-5 presents the 10 pollutants with the highest emissions from the 2014 NEI (version 1) that have cancer toxicity factors. Table 15-5 also presents the 10 pollutants with the highest toxicity-weighted emissions, based on the weighting schema described in Section 3.4.2.4. Lastly, Table 15-5 provides the pollutants of interest with the highest cancer risk approximations (in-a-million) for S4MO, as presented in Table 15-4. Cancer risk approximations for 2015 are presented in green while approximations for 2016 are in white. The emissions, toxicity-weighted emissions, and cancer risk approximations are shown in descending order in Table 15-5. Table 15-6 presents similar information, but is limited to those pollutants with noncancer toxicity factors.

Because not all pollutants have both cancer and noncancer toxicity factors, the highest emitted pollutants in the cancer table may be different from the noncancer table, although the actual quantity of emissions is the same. The cancer risk and noncancer hazard approximations based on each site's annual averages are limited to the pollutants of interest identified for each site. In addition, the cancer risk and noncancer hazard approximations are limited to those pollutants with enough data to meet the criteria for annual averages to be calculated. A more in-depth discussion of this analysis is provided in Section 3.4.2.4. Similar to the cancer risk and noncancer hazard approximations provided in Section 15.4.1, this analysis may help policy-makers prioritize their air monitoring activities.

Table 15-5. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Missouri Monitoring Site

Top 10 Total Emissions for Pollutants with Cancer UREs (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
St. Louis, Missouri (St. Louis City + County) - S4MO					
Formaldehyde	428.58	Formaldehyde	5.57E-03	Formaldehyde	41.49
Benzene	409.22	Naphthalene	3.38E-03	Formaldehyde	40.19
Acetaldehyde	250.69	Benzene	3.19E-03	Benzene	5.17
Ethylbenzene	238.48	1,3-Butadiene	1.96E-03	Benzene	4.81
Naphthalene	99.40	Hexavalent Chromium, PM	1.10E-03	Carbon Tetrachloride	3.88
1,3-Butadiene	65.33	POM, Group 2b	7.74E-04	Arsenic	3.86
Bis(2-ethylhexyl) phthalate, gas	63.69	POM, Group 2d	6.31E-04	Arsenic	3.77
Trichloroethylene	32.97	Arsenic, PM	6.18E-04	Carbon Tetrachloride	3.77
POM, Group 2b	8.79	Ethylbenzene	5.96E-04	Acetaldehyde	3.65
POM, Group 2d	7.17	Acetaldehyde	5.52E-04	Acetaldehyde	3.51

[1] Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Table 15-6. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the Missouri Monitoring Site

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific) [1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Hazard Approximation (HQ)**
St. Louis, Missouri (St. Louis City + County) - S4MO					
Toluene	1,563.52	Acrolein	1,485,460.58	Formaldehyde	0.33
Xylenes	875.34	2,4-Toluene diisocyanate	87,183.14	Formaldehyde	0.32
Methanol	694.65	Formaldehyde	43,732.45	Acetaldehyde	0.18
Formaldehyde	428.58	Naphthalene	33,133.17	Acetaldehyde	0.18
Benzene	409.22	1,3-Butadiene	32,666.95	Arsenic	0.06
Hexane	280.51	Acetaldehyde	27,854.05	Arsenic	0.06
Acetaldehyde	250.69	Trichloroethylene	16,482.55	1,3-Butadiene	0.05
Ethylbenzene	238.48	Benzene	13,640.63	1,3-Butadiene	0.04
Naphthalene	99.40	Cadmium, PM	12,122.02	Naphthalene	0.03
Ethylene glycol	85.32	Arsenic, PM	9,577.54	Naphthalene	0.02

[1] Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Observations from Table 15-5 include the following:

- Emissions and toxicity-weighted emissions for S4MO are presented as the city-based (FIPS 29-189) emissions summed with the county-based emissions (29-510).

- Formaldehyde, benzene, and acetaldehyde are the highest emitted pollutants with cancer UREs in St. Louis.

- The pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) are formaldehyde, naphthalene, and benzene.

- Eight of the highest emitted pollutants also have the highest toxicity-weighted emissions.

- Formaldehyde tops all three lists, with the highest quantity emitted, the highest toxicity-weighted emissions, and the highest cancer risk approximations. Benzene, and acetaldehyde also appear on all three lists.

- Arsenic has the sixth and seventh highest cancer risk approximations for S4MO. While arsenic is not one of the highest emitted pollutants in St. Louis, it ranks eighth for its toxicity-weighted emissions. Carbon tetrachloride also appears among the pollutants of interest with the highest cancer risk approximations for S4MO but appears on neither emissions-based list.

- POM, Group 2b is the ninth highest emitted "pollutant" in St. Louis and ranks sixth for toxicity-weighted emissions. POM, Group 2b includes several PAHs sampled for at S4MO including acenaphthene and fluorene, which are pollutants of interest for S4MO. These pollutants are not among those with the highest cancer risk approximations for S4MO.

Observations from Table 15-6 include the following:

- Emissions and toxicity-weighted emissions for S4MO are presented as the city-based (FIPS 29-189) emissions summed with the county-based emissions (29-510).

- Toluene, xylenes, and methanol are the highest emitted pollutants with noncancer RfCs in St. Louis.

- The pollutants with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) are acrolein, 2,4-toluene diisocyanate, and formaldehyde. Although acrolein was sampled for at S4MO, this pollutant was excluded from the pollutants of interest designation, and thus, subsequent risk-based screening evaluations, due to questions about the consistency and reliability of the measurements, as discussed in Section 3.2.

- Four of the highest emitted pollutants in St. Louis also have the highest toxicity-weighted emissions.

- Formaldehyde, the pollutant with highest noncancer hazard approximations for S4MO, has the third highest toxicity-weighted emissions and the fourth highest total

emissions (of the pollutants with noncancer RfCs). Acetaldehyde and naphthalene also appear on all three lists.

- Arsenic and 1,3-butadiene, both pollutants of interest for S4MO, appear among the pollutants with the highest toxicity-weighted emissions, but are not among the highest emitted.

15.5 Summary of the 2015-2016 Monitoring Data for S4MO

Results from several of the data analyses described in this section include the following:

- ❖ *Twenty-two pollutants failed screens for S4MO. S4MO failed the highest number of screens among all NMP sites.*

- ❖ *Formaldehyde and acetaldehyde have the highest annual average concentrations for S4MO. These are the only pollutants of interest with annual averages greater than 1 µg/m^3.*

- ❖ *S4MO has the third and sixth highest annual average concentrations of p-dichlorobenzene among NMP sites sampling VOCs. S4MO also has some of the highest annual average concentrations of arsenic, acenaphthene, fluorene, and naphthalene among NMP sites sampling these pollutants.*

- ❖ *Concentrations of acetaldehyde, benzene, and ethylbenzene have decreased significantly since sampling began at S4MO.*

- ❖ *Formaldehyde has the highest cancer risk approximations of the pollutants of interest for S4MO. None of the pollutants of interest for S4MO have noncancer hazard approximations greater than an HQ of 1.0.*

16.0 Sites in New Jersey

This section summarizes those data from samples collected at UATMP sites in New Jersey and generated by ERG, EPA's contract laboratory for the NMP, over the 2015 and 2016 monitoring efforts. This section also examines the spatial and temporal characteristics of the ambient monitoring concentrations and reviews them through the context of risk. Readers are encouraged to refer to Sections 1 through 4 for detailed discussions and definitions regarding the various data analyses presented below.

Data generated by sources other than ERG, EPA's contract laboratory for the NMP, are not included in the data analyses contained in this report.

16.1 Site Characterization

This section characterizes the New Jersey monitoring sites by providing a description of the nearby area surrounding each monitoring site; plotting emissions sources surrounding the monitoring sites; and presenting traffic data and other characterizing information for each site. This information is provided to give the reader insight regarding factors that may influence the air quality near the sites and assist in the interpretation of the ambient measurements.

One New Jersey monitoring site (CSNJ) is located in the Philadelphia-Camden-Wilmington, PA-NJ-DE-MD CBSA while the other four New Jersey sites (CHNJ, ELNJ, NBNJ, and NRNJ) are located within the New York-Newark-Jersey City, NY-NJ-PA CBSA. Figure 16-1 presents a composite satellite image retrieved from ArcGIS Explorer showing the CSNJ monitoring site and its immediate surroundings. Figure 16-2 identifies nearby point source emissions locations by source category, as reported in the 2014 NEI for point sources, version 1. Note that only sources within 10 miles of CSNJ are included in the facility counts provided in Figure 16-2. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have a direct effect on the air quality at the monitoring site. Further, this boundary provides both the proximity of emissions sources to the monitoring site as well as the quantity of such sources within a given distance of the site. Sources outside the 10-mile boundary are still visible on the map for reference but have been grayed out to emphasize emissions sources within the boundary. Figures 16-3 through 16-8 present the composite satellite maps and emissions source maps for CHNJ, ELNJ, NBNJ, and NRNJ. Table 16-1 provides supplemental geographical information for each site, such as land use, location setting, and locational coordinates. Each figure and table is discussed in detail in the paragraphs that follow.

Figure 16-1. Camden, New Jersey (CSNJ) Monitoring Site

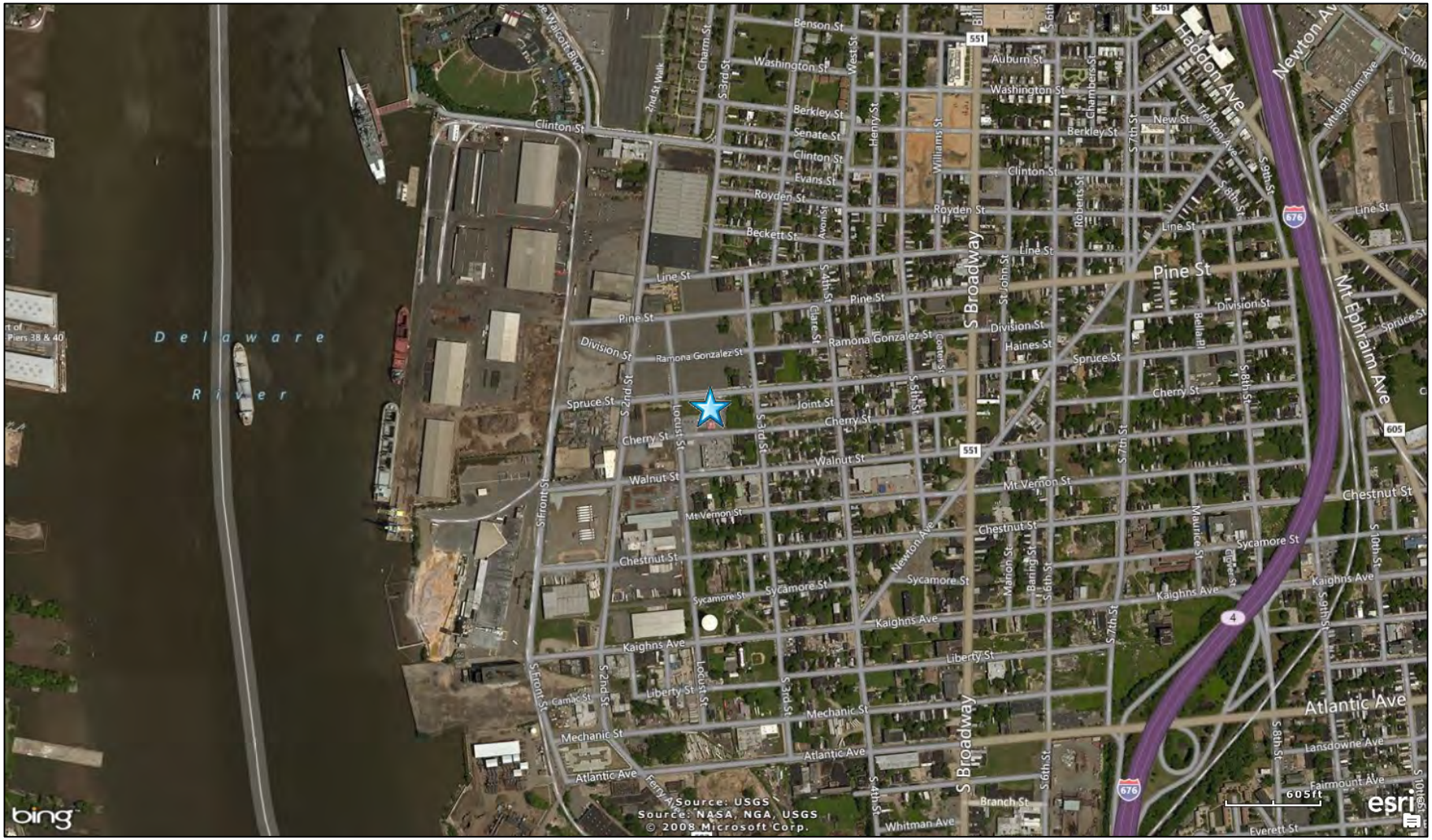


Figure 16-2. NEI Point Sources Located Within 10 Miles of CSNJ

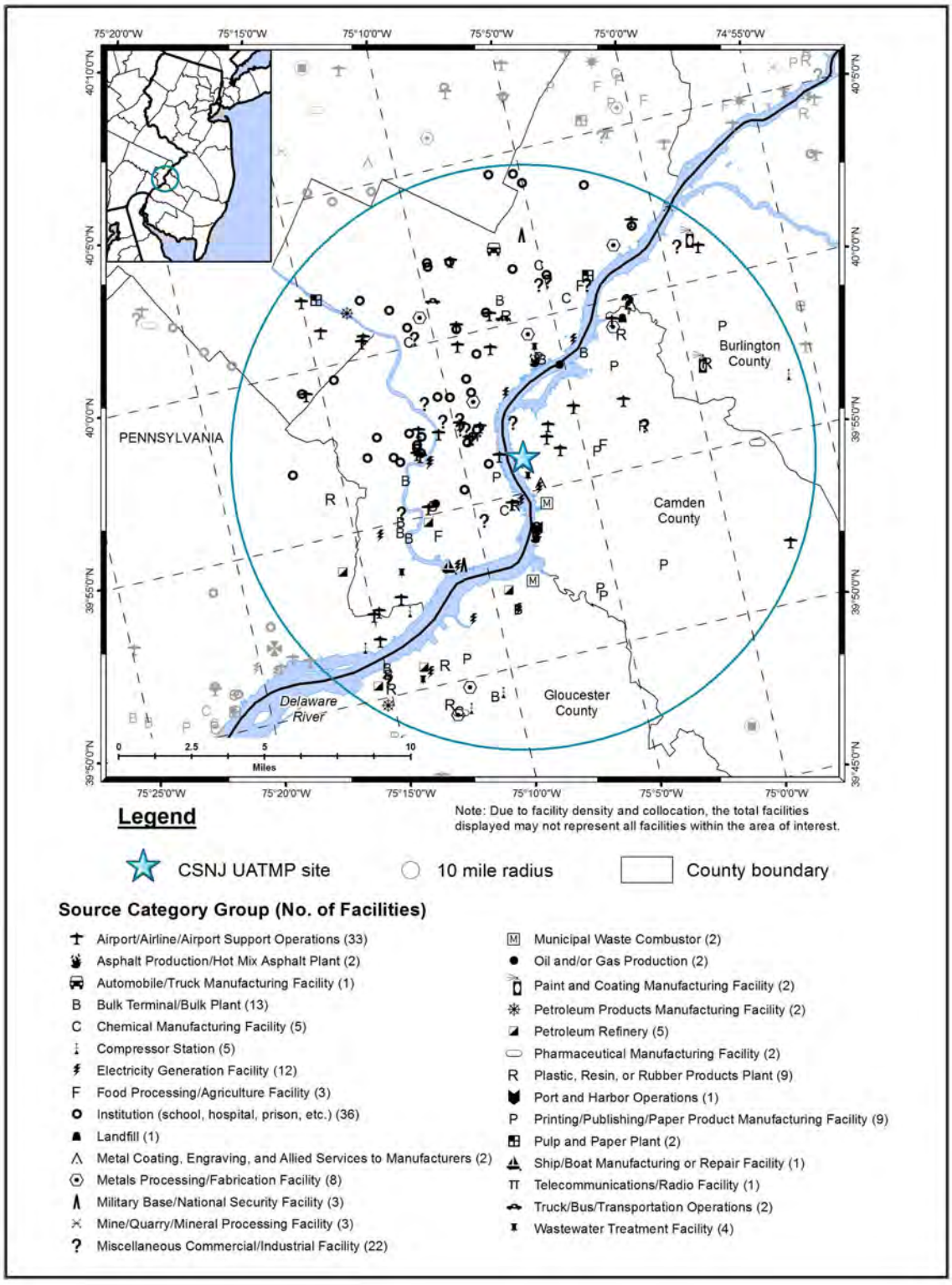


Figure 16-3. Chester, New Jersey (CHNJ) Monitoring Site

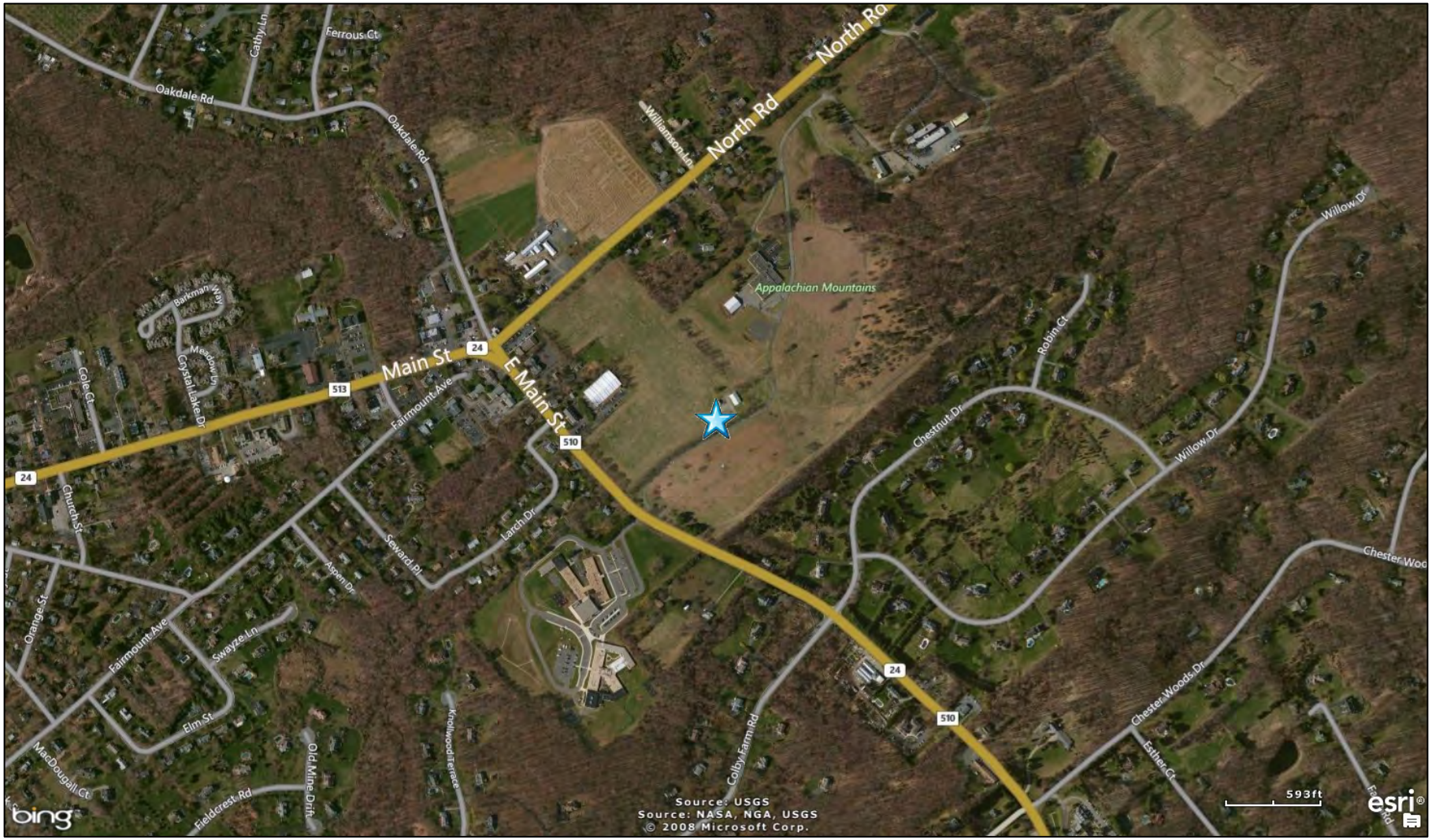


Figure 16-4. NEI Point Sources Located Within 10 Miles of CHNJ

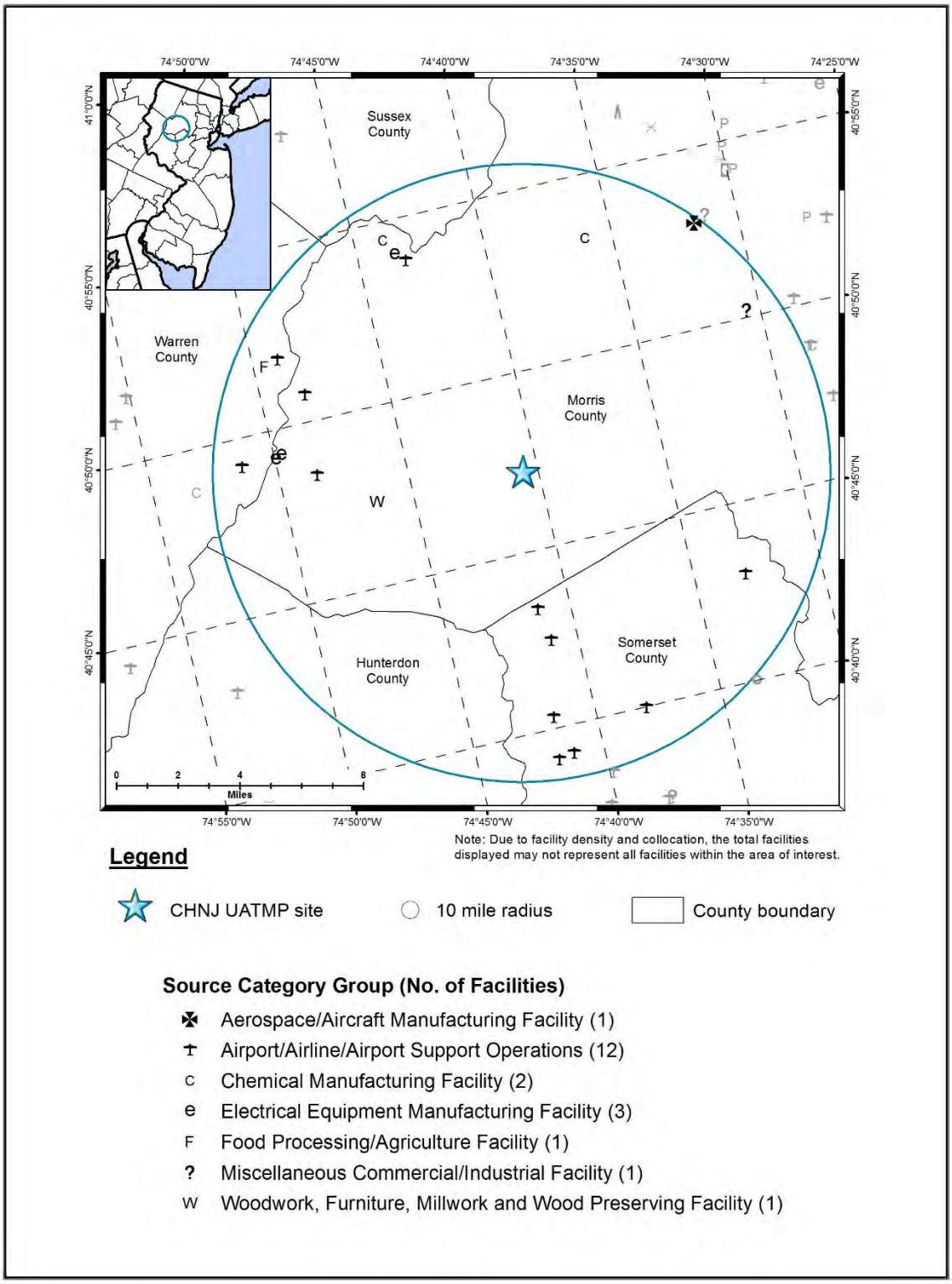


Figure 16-5. Elizabeth, New Jersey (ELNJ) Monitoring Site

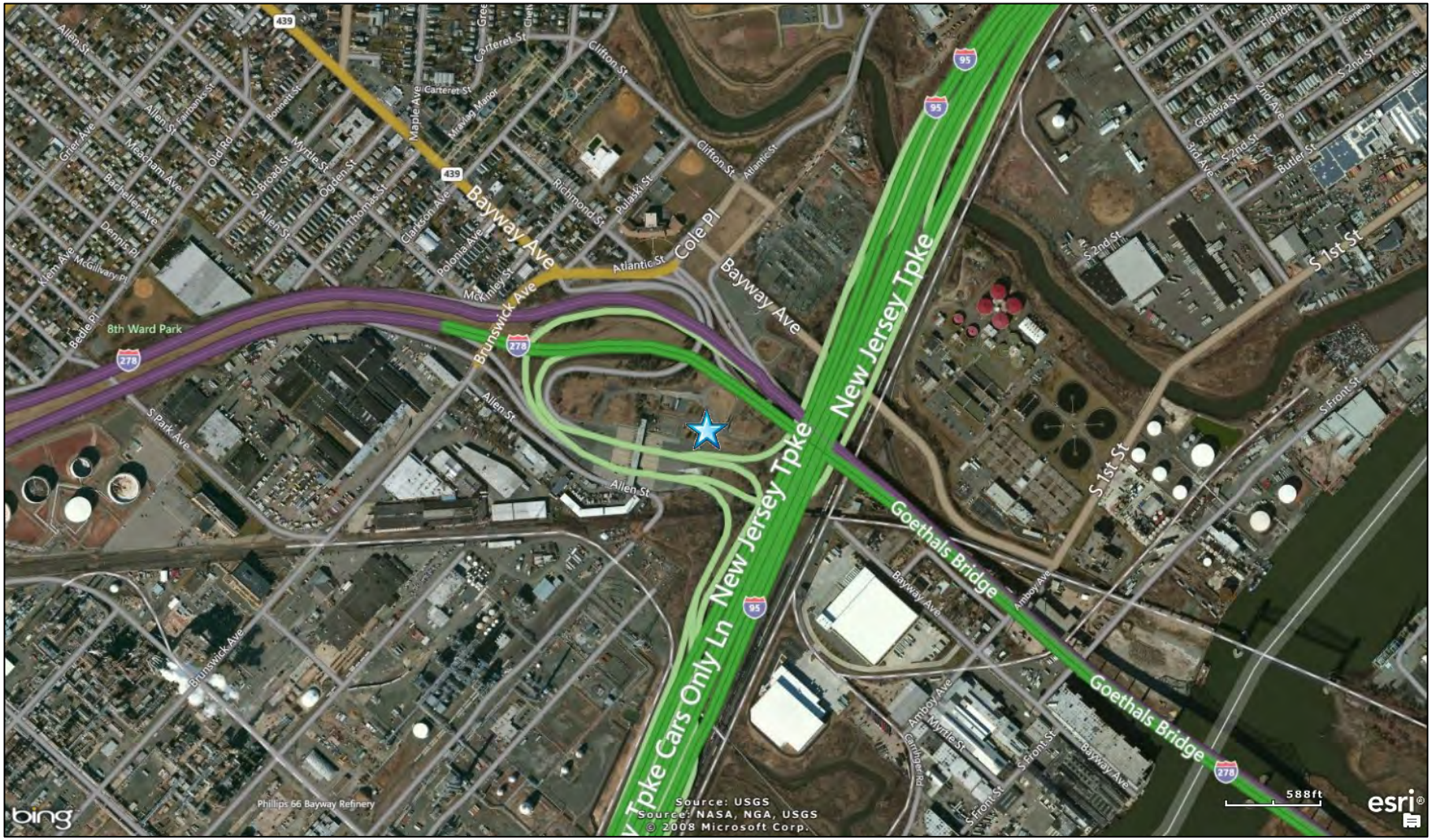


Figure 16-6. North Brunswick, New Jersey (NBNJ) Monitoring Site

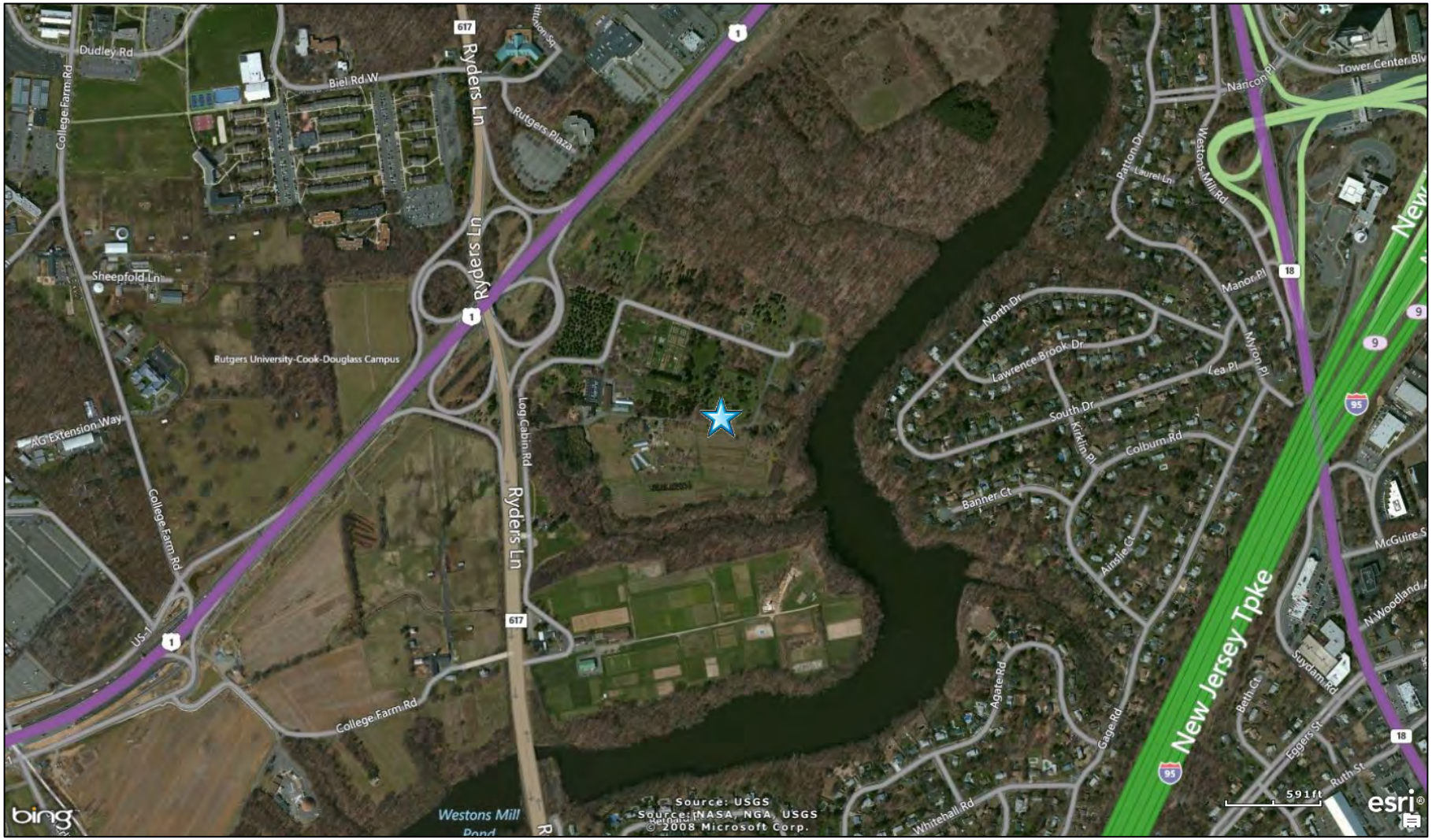


Figure 16-7. East Brunswick, New Jersey (NRNJ) Monitoring Site

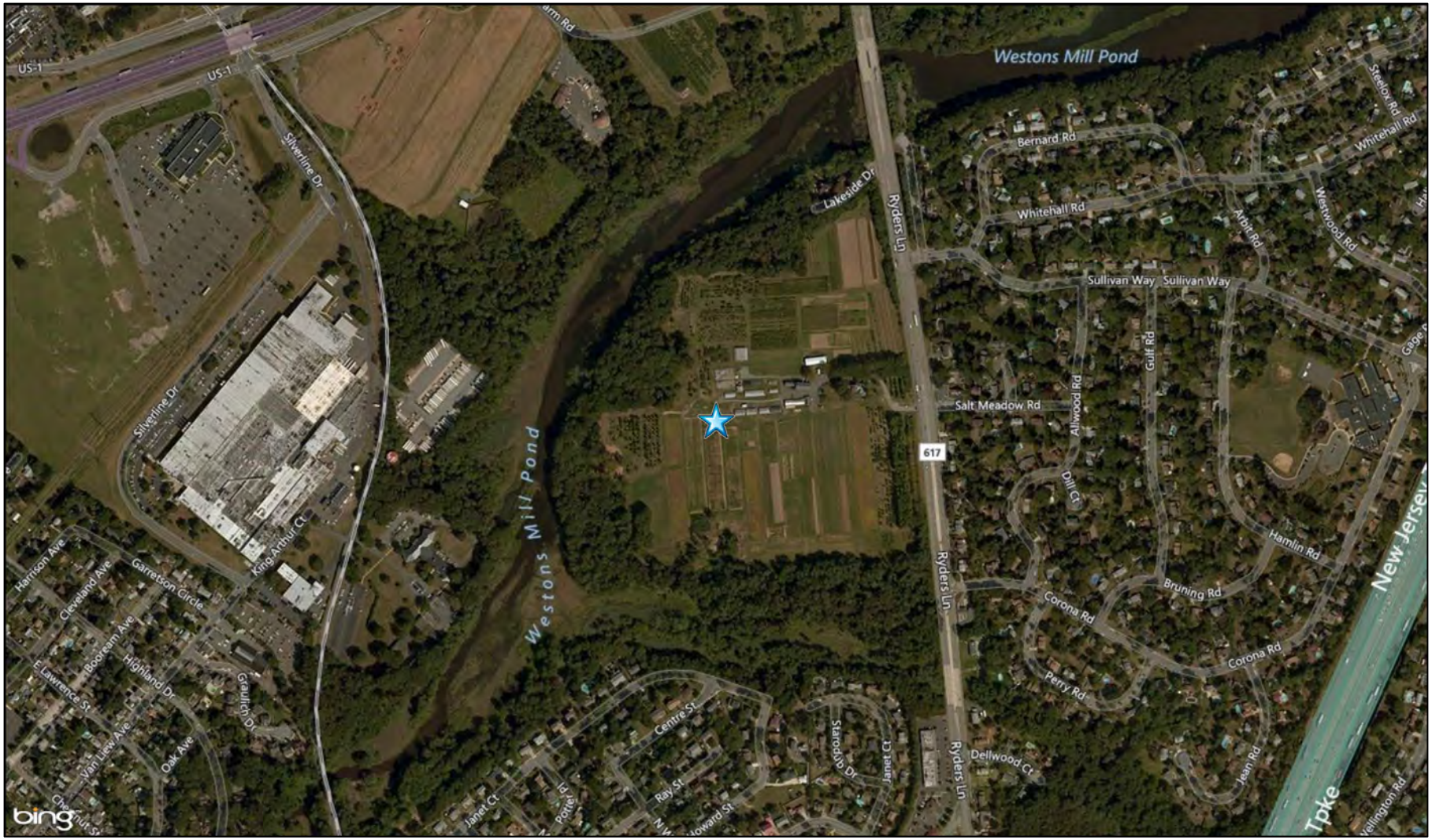


Figure 16-8. NEI Point Sources Located Within 10 Miles of ELNJ, NBNJ, and NRNJ

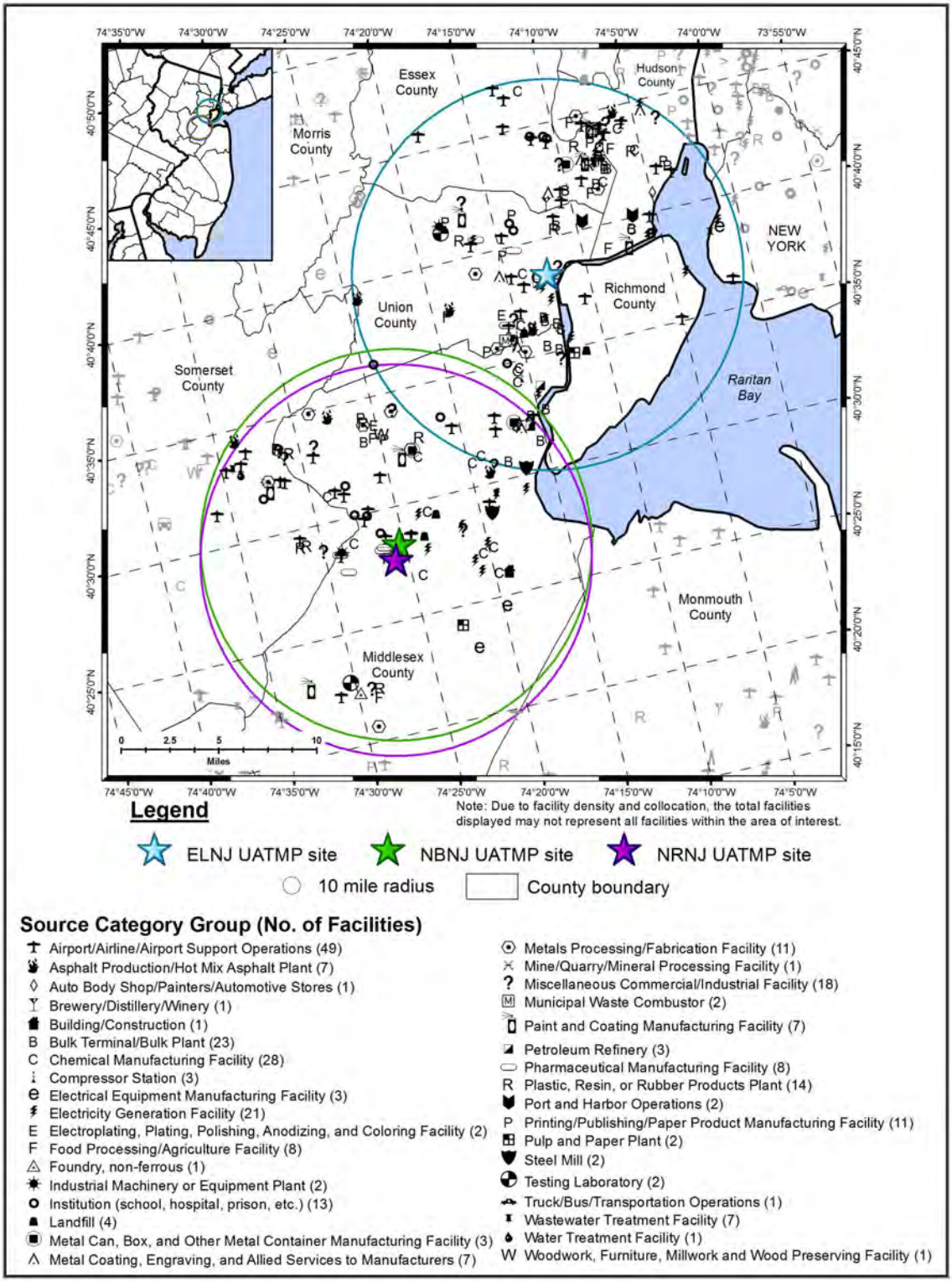


Table 16-1. Geographical Information for the New Jersey Monitoring Sites

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Annual Average Daily Traffic[3]	Intersection Used for Traffic Data
CSNJ	34-007-0002	Camden	Camden	Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	39.934446, -75.125291	Industrial	Urban/City Center	3,231	S 2nd St, south of Walnut St
CHNJ	34-027-3001	Chester	Morris	New York-Newark-Jersey City, NY-NJ-PA	40.787628, -74.676301	Agricultural	Rural	11,215	Mendham Rd (510/24), east of Fox Chase Rd
ELNJ	34-039-0004	Elizabeth	Union	New York-Newark-Jersey City, NY-NJ-PA	40.641440, -74.208365	Industrial	Suburban	250,000	I-95, between Exits 13 & 13A
NBNJ	34-023-0006	North Brunswick	Middlesex	New York-Newark-Jersey City, NY-NJ-PA	40.472825, -74.422403	Agricultural	Rural	114,322	US-1, E of Ryders Ln/617
NRNJ	34-023-0011	East Brunswick	Middlesex	New York-Newark-Jersey City, NY-NJ-PA	40.462182, -74.429439	Agricultural	Rural	22,297	Ryders Ln/617, between I-95 and Blueberry Dr

[3]AADT for ELNJ reflects 2006 data from NJ Department of Treasury (NJ DOTr, 2008); AADT reflects 2010 data for NBNJ, 2012 data for CSNJ and CHNJ, and 2014 data for NRNJ from the NJ DOT (NJ DOT, 2016).

The CSNJ monitoring site is located in the city of Camden in southwest New Jersey, just across the state line from Philadelphia, Pennsylvania. The monitoring site is located in an industrial area a few blocks east of the Delaware River, as shown in Figure 16-1. Residential areas are located to the east between the site and I-676. Figure 16-2 shows that the large number of point sources located within 10 miles of CSNJ are involved in a variety of industries. The source categories with the largest number of facilities within 10 miles of CSNJ include institutions (such as schools, hospitals, and prisons); airports and airport support operations, which include airports and related operations as well as small runways and heliports, such as those associated with hospitals or television stations; bulk terminals and bulk plants; and electricity generating facilities. The sources closest to CSNJ include a metals processing and fabrication facility; a mine/quarry/minerals processing facility; a wastewater treatment facility; and an airport/airport operations facility.

CHNJ is located in northern New Jersey, in the town of Chester, west of the New York City metropolitan area. Figure 16-3 shows that CHNJ is located in an open area near Building 1 of the Department of Public Works, off Routes 513 (North Road) and 510 (Main Street). The surrounding area is rural and agricultural, with a rolling topography, but surrounded by small neighborhoods. Two schools are located on the other site of Route 510 to the south-southwest of CHNJ. Although the location is considered part of the New York City metro area, the site's location is outside most of the urbanized areas. Figure 16-4 shows that few sources are located within a few miles of CHNJ. The source category with the greatest number of emissions sources within 10 miles of CHNJ is the airport source category. The sources closest to CHNJ include a privately-owned heliport to the south and a woodwork, furniture, millwork, and wood preserving facility to the west.

ELNJ is located in the city of Elizabeth, which lies just south of Newark and west of Newark Bay and Staten Island, New York. As Figure 16-5 shows, the monitoring site is located near the toll plaza just off Exit 13 of the New Jersey Turnpike (I-95). Interstate-278 intersects the Turnpike here as well. The surrounding area is highly industrialized, with an oil refinery located just southwest of the site. Additional industry is located to the southwest, west, and on the east side of the Turnpike, while a school and park are located to the north and residential neighborhoods are located to the northwest. The New Jersey/New York border can be seen in the lower right-hand corner of Figure 16-5, with Staten Island on the east side of the Arthur Kill channel.

NBNJ is located in North Brunswick, approximately 16 miles southwest of Elizabeth. The monitoring site is located on the property of Rutgers University's Cook-Douglass campus, on a horticultural farm. The surrounding area is agricultural and rural, although residential neighborhoods are located to the east, across a branch of the Raritan River, as shown in Figure 16-6. County Road 617 (Ryders Lane) and US-1 intersect just west of the site and the New Jersey Turnpike/I-95 runs northeast-southwest less than 1 mile east of the site.

The sampling equipment at NBNJ was moved to a new location (NRNJ) for 2016. NRNJ is located just less than 1 mile farther south down Ryders Lane. This site is still located on Rutgers University, but moved to horticultural farm number 3, the fields of which are a prominent feature in Figure 16-7. The area is classified as agricultural, with residential properties located to the east and south. Weston's Mill Pond, a section of the Lawrence Brook, a tributary of the Raritan River, runs to the north and west of the farm (LBWP, 2013) and separates the farm from a window and door manufacturing facility located about one half-mile to the west. Both NBNJ and NRNJ are wedged between I-95 to the east, which can be seen in the lower right-hand corner of Figure 16-7, and US-1 to the northwest, shown in the upper left-hand corner, with NRNJ roughly one-half mile from each.

Figure 16-8 provides the emissions sources for ELNJ, NBNJ, and NRNJ on one map, as the outer portions of the 10-mile boundaries for these three sites intersect; NBNJ and NRNJ are 16 miles and 17 miles southwest of ELNJ, respectively. Many emissions sources surround these sites. The majority of the emissions sources are located in the northern half of Middlesex County and northeastward toward New York City and northern New Jersey. The source categories with the greatest number of emissions sources in the vicinity of these sites include airport operations, chemical manufacturing, bulk terminals and bulk plants, and electricity generation via combustion. The emissions sources in closest proximity to the ELNJ monitoring site are in the wastewater treatment, chemical manufacturing, bulk terminals/bulk plant, petroleum refining, miscellaneous commercial/industrial facility, and electricity generation via combustion source categories. The emissions sources in closest proximity to the NBNJ and NRNJ monitoring sites are involved in airport and airport support operations, pharmaceutical manufacturing, and plastic, resin, or rubber products manufacturing.

In addition to providing city, county, CBSA, and land use/location setting information, Table 16-1 also contains traffic volume information for each site as well as the location for which the traffic volume was obtained. This information is provided because emissions from motor vehicles can significantly affect concentrations measured at a given monitoring site. ELNJ experiences the highest traffic volume among the New Jersey sites (250,000); this is not unexpected given ELNJ's location along the New Jersey Turnpike/I-95, between Exit 13 and 13A. ELNJ's traffic volume is also the highest among all NMP sites. The traffic volume for NBNJ is about half that experienced near ELNJ, with the volumes near the remaining sites considerably less. Traffic data for NBNJ are provided for US-1, east of State Road 617 (Ryders Lane); traffic data for NRNJ are provided for Ryders Lane, between Blueberry Drive and I-95; traffic data for CHNJ are provided for Route 510, east of Fox Chase Road; and traffic data for CSNJ are provided for South 2nd Street, south of Walnut Street.

16.2 Pollutants of Interest

The risk-based screening process described in Section 3.2 was performed for each site to identify site-specific "pollutants of interest," which allows analysts and readers to focus on a subset of pollutants through the context of risk. For each site, each pollutant's preprocessed daily measurement was compared to its associated risk screening value. If the concentration was greater than the risk screening value, then the concentration "failed the screen." The site-specific results of this risk-based screening process are presented in Table 16-2 and incorporate measurements from both 2015 and 2016. Pollutants of interest are those for which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens and are shaded in gray in Table 16-2. It is important to note which pollutants were sampled for at each site when reviewing the results of this analysis. VOCs and carbonyl compounds were sampled for at each of the New Jersey sites.

Table 16-2. 2015-2016 Risk-Based Screening Results for the New Jersey Monitoring Sites

Pollutant	Screening Value (µg/m^3)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Camden, New Jersey - CSNJ						
Formaldehyde	0.077	119	119	100.00	14.53	14.53
Acetaldehyde	0.45	118	119	99.16	14.41	28.94
Benzene	0.13	116	116	100.00	14.16	43.10
Carbon Tetrachloride	0.17	116	116	100.00	14.16	57.26
1,3-Butadiene	0.03	111	114	97.37	13.55	70.82
1,2-Dichloroethane	0.038	109	109	100.00	13.31	84.13
Ethylbenzene	0.4	53	116	45.69	6.47	90.60
Bromomethane	0.5	23	116	19.83	2.81	93.41
p-Dichlorobenzene	0.091	20	63	31.75	2.44	95.85
Hexachloro-1,3-butadiene	0.045	16	17	94.12	1.95	97.80
Trichloroethylene	0.2	8	54	14.81	0.98	98.78
1,2-Dibromoethane	0.0017	5	5	100.00	0.61	99.39
Propionaldehyde	0.8	3	119	2.52	0.37	99.76
Dichloromethane	60	1	116	0.86	0.12	99.88
Vinyl chloride	0.11	1	64	1.56	0.12	100.00
Total		819	1,363	60.09		
Chester, New Jersey - CHNJ						
Carbon Tetrachloride	0.17	112	113	99.12	20.14	20.14
Benzene	0.13	111	113	98.23	19.96	40.11
1,2-Dichloroethane	0.038	103	103	100.00	18.53	58.63
Formaldehyde	0.077	94	94	100.00	16.91	75.54
Acetaldehyde	0.45	89	94	94.68	16.01	91.55
1,3-Butadiene	0.03	30	72	41.67	5.40	96.94
Hexachloro-1,3-butadiene	0.045	12	13	92.31	2.16	99.10
1,2-Dibromoethane	0.0017	3	3	100.00	0.54	99.64
p-Dichlorobenzene	0.091	2	25	8.00	0.36	100.00
Total		556	630	88.25		

Table 16-2. 2015-2016 Risk-Based Screening Results for the New Jersey Monitoring Sites (Continued)

Pollutant	Screening Value (µg/m^3)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Elizabeth, New Jersey - ELNJ						
Acetaldehyde	0.45	121	121	100.00	15.59	15.59
Formaldehyde	0.077	121	121	100.00	15.59	31.19
Benzene	0.13	120	120	100.00	15.46	46.65
Carbon Tetrachloride	0.17	120	120	100.00	15.46	62.11
1,3-Butadiene	0.03	117	120	97.50	15.08	77.19
1,2-Dichloroethane	0.038	112	112	100.00	14.43	91.62
Ethylbenzene	0.4	27	120	22.50	3.48	95.10
p-Dichlorobenzene	0.091	14	65	21.54	1.80	96.91
Propionaldehyde	0.8	13	121	10.74	1.68	98.58
Hexachloro-1,3-butadiene	0.045	7	9	77.78	0.90	99.48
1,2-Dibromoethane	0.0017	4	4	100.00	0.52	100.00
Total		776	1033	75.12		
North Brunswick, New Jersey - NBNJ						
Acetaldehyde	0.45	59	59	100.00	17.15	17.15
Benzene	0.13	59	59	100.00	17.15	34.30
Carbon Tetrachloride	0.17	59	59	100.00	17.15	51.45
1,2-Dichloroethane	0.038	59	59	100.00	17.15	68.60
Formaldehyde	0.077	59	59	100.00	17.15	85.76
1,3-Butadiene	0.03	41	54	75.93	11.92	97.67
Hexachloro-1,3-butadiene	0.045	3	3	100.00	0.87	98.55
1,2-Dibromoethane	0.0017	2	2	100.00	0.58	99.13
Propionaldehyde	0.8	2	59	3.39	0.58	99.71
p-Dichlorobenzene	0.091	1	22	4.55	0.29	100.00
Total		344	435	79.08		
East Brunswick, New Jersey - NRNJ						
Acetaldehyde	0.45	60	60	100.00	16.04	16.04
Benzene	0.13	60	60	100.00	16.04	32.09
Carbon Tetrachloride	0.17	60	60	100.00	16.04	48.13
Formaldehyde	0.077	60	60	100.00	16.04	64.17
1,2-Dichloroethane	0.038	57	57	100.00	15.24	79.41
1,3-Butadiene	0.03	47	52	90.38	12.57	91.98
Hexachloro-1,3-butadiene	0.045	16	17	94.12	4.28	96.26
Ethylbenzene	0.4	6	60	10.00	1.60	97.86
1,2-Dibromoethane	0.0017	4	4	100.00	1.07	98.93
p-Dichlorobenzene	0.091	4	30	13.33	1.07	100.00
Total		374	460	81.30		

Observations from Table 16-2 include the following:

- Concentrations of 15 pollutants failed at least one screen for CSNJ; 60 percent of concentrations for these 15 pollutants were greater than their associated risk screening value (or failed screens).

- Nine pollutants contributed to 95 percent of failed screens for CSNJ and therefore were identified as pollutants of interest for this site. These nine include two carbonyl compounds and seven VOCs. CSNJ is the only NMP site for which bromomethane is a pollutant of interest.

- Concentrations of nine pollutants failed at least one screen for CHNJ; 88 percent of concentrations for these nine pollutants were greater than their associated risk screening value (or failed screens).

- Six pollutants contributed to 95 percent of failed screens for CHNJ and therefore were identified as pollutants of interest for this site. These six include two carbonyl compounds and four VOCs.

- Concentrations of 11 pollutants failed at least one screen for ELNJ, with 75 percent of concentrations for these 11 pollutants greater than their associated risk screening value (or failing screens).

- Seven pollutants contributed to 95 percent of failed screens for ELNJ and therefore were identified as pollutants of interest for this site. These seven include two carbonyl compounds and five VOCs.

- Concentrations of 10 pollutants failed at least one screen for NBNJ, with 79 percent of concentrations for these 10 pollutants greater than their associated risk screening value (or failing screens).

- Six pollutants contributed to 95 percent of failed screens for NBNJ and therefore were identified as pollutants of interest for this site. These six include two carbonyl compounds and four VOCs.

- Concentrations of 10 pollutants failed at least one screen for NRNJ, with 81 percent of concentrations for these 10 pollutants greater than their associated risk screening value (or failing screens).

- Seven pollutants contributed to 95 percent of failed screens for NRNJ and therefore were identified as pollutants of interest for this site. These seven include two carbonyl compounds and five VOCs.

- The New Jersey sites have six pollutants of interest in common: acetaldehyde, formaldehyde, benzene, carbon tetrachloride, 1,3-butadiene, and 1,2-dichloroethane.

For each of the data analyses described in the remaining sections, the focus is on the site-specific pollutants of interest identified via the risk-based screening process, as described in Section 3.4.2.

16.3 Concentrations

This section presents various concentration averages used to characterize air toxics concentration levels at the New Jersey monitoring sites. Where applicable, the following calculations and data analyses were performed for each of the site-specific pollutants of interest:

- Time period-based concentration averages (quarterly and annual) are provided for each monitoring site for each year of monitoring.
- The range of measurements and annual concentration averages are presented graphically for each site to illustrate how the site's concentrations compare to the program-level averages, as presented in Section 4.1.
- Concentration averages and other statistical metrics for 2015, 2016, and from previous years of monitoring are presented in order to characterize concentration trends at each site.

Each data analysis is performed where the applicable criteria are met (as specified in the appropriate sections discussed below) and is limited to the site-specific pollutants of interest. However, site-specific statistical summaries for all pollutants sampled for at the New Jersey monitoring sites are provided in Appendices J and M.

16.3.1 2015 and 2016 Concentration Averages

Quarterly and annual concentration averages for 2015 and 2016 were calculated for the pollutants of interest for each New Jersey site, as described in Section 3.1. The *quarterly average concentration* of a particular pollutant is simply the average concentration of the preprocessed daily measurements over a given calendar quarter. Quarterly average concentrations include the substitution of zeros for all non-detects. A site must have a minimum of 75 percent valid samples compared to the total number of samples possible within a given calendar quarter for a quarterly average to be calculated. An *annual average concentration* includes all measured detections and substituted zeros for non-detects for an entire year of sampling. Annual averages were calculated for pollutants where three valid quarterly averages could be calculated for a given year and where method completeness was greater than or equal to 85 percent, as presented in Section 2.4. Quarterly and annual average concentrations for the pollutants of interest for the New Jersey monitoring sites are presented in Table 16-3, where applicable. Note that if a pollutant was not detected in a given calendar quarter, the quarterly average simply reflects "0" because only zeros substituted for non-detects were factored into the quarterly average concentration. As the instrumentation at NBNJ was moved to NRNJ for 2016, only one year of data is provided for each site.

Table 16-3. Quarterly and Annual Average Concentrations of the Pollutants of Interest for the New Jersey Monitoring Sites

Pollutant	2015						2016					
	# of Detects/ # >MDL/ # Samples	Q1 Avg (µg/m³)	Q2 Avg (µg/m³)	Q3 Avg (µg/m³)	Q4 Avg (µg/m³)	Annual Average (µg/m³)	# of Detects/ # >MDL/ # Samples	Q1 Avg (µg/m³)	Q2 Avg (µg/m³)	Q3 Avg (µg/m³)	Q4 Avg (µg/m³)	Annual Average (µg/m³)
Camden, New Jersey - CSNJ												
Acetaldehyde	59/59/59	1.52 ± 0.25	2.00 ± 0.33	2.69 ± 0.72	1.90 ± 0.50	2.03 ± 0.25	60/60/60	2.29 ± 0.55	2.35 ± 0.54	3.61 ± 1.22	2.45 ± 0.54	2.65 ± 0.37
Benzene	61/61/61	0.97 ± 0.20	0.66 ± 0.10	0.58 ± 0.10	1.16 ± 0.41	0.86 ± 0.14	55/55/55	0.87 ± 0.25	0.55 ± 0.12	0.54 ± 0.14	0.97 ± 0.27	0.74 ± 0.11
Bromomethane	61/60/61	1.15 ± 0.74	2.46 ± 3.15	0.07 ± 0.03	0.30 ± 0.41	0.93 ± 0.74	55/22/55	0.95 ± 0.74	0.35 ± 0.32	0.08 ± 0.01	0.10 ± 0.04	0.41 ± 0.24
1,3-Butadiene	61/59/61	0.10 ± 0.02	0.07 ± 0.02	0.05 ± 0.01	0.14 ± 0.05	0.09 ± 0.02	53/36/55	0.11 ± 0.05	0.06 ± 0.02	0.05 ± 0.01	0.11 ± 0.04	0.08 ± 0.02
Carbon Tetrachloride	61/61/61	0.57 ± 0.08	0.64 ± 0.03	0.64 ± 0.04	0.64 ± 0.03	0.62 ± 0.02	55/55/55	0.57 ± 0.07	0.72 ± 0.03	0.60 ± 0.08	0.64 ± 0.04	0.63 ± 0.03
p-Dichlorobenzene	34/2/61	0.02 ± 0.01	0.04 ± 0.03	0.05 ± 0.02	0.07 ± 0.03	0.05 ± 0.01	29/5/55	0.04 ± 0.03	0.09 ± 0.07	0.04 ± 0.03	0.07 ± 0.06	0.06 ± 0.02
1,2-Dichloroethane	60/55/61	0.09 ± 0.01	0.11 ± 0.03	0.06 ± 0.01	0.09 ± 0.02	0.09 ± 0.01	49/49/55	0.09 ± 0.01	0.10 ± 0.02	0.04 ± 0.02	0.07 ± 0.02	0.08 ± 0.01
Ethylbenzene	61/61/61	0.30 ± 0.06	0.43 ± 0.08	0.40 ± 0.07	0.54 ± 0.15	0.42 ± 0.06	55/55/55	0.30 ± 0.12	0.32 ± 0.13	0.69 ± 0.25	0.64 ± 0.19	0.47 ± 0.09
Formaldehyde	59/59/59	2.05 ± 0.26	3.60 ± 0.90	5.48 ± 0.77	3.14 ± 0.68	3.57 ± 0.46	60/60/60	3.62 ± 0.84	4.34 ± 1.00	4.57 ± 1.00	3.78 ± 0.70	4.06 ± 0.43

NA = Not available because the criteria for calculating a quarterly and/or annual average were not met.
NS = Sampling was not conducted during this time.

Table 16-3. Quarterly and Annual Average Concentrations of the Pollutants of Interest for the New Jersey Monitoring Sites (Continued)

Pollutant	2015 # of Detects/ # >MDL/ # Samples	2015 Q1 Avg (µg/m³)	2015 Q2 Avg (µg/m³)	2015 Q3 Avg (µg/m³)	2015 Q4 Avg (µg/m³)	2015 Annual Average (µg/m³)	2016 # of Detects/ # >MDL/ # Samples	2016 Q1 Avg (µg/m³)	2016 Q2 Avg (µg/m³)	2016 Q3 Avg (µg/m³)	2016 Q4 Avg (µg/m³)	2016 Annual Average (µg/m³)
Chester, New Jersey - CHNJ												
Acetaldehyde	34/34/34	1.08 ± 0.22	NA	NA	0.98 ± 0.29	NA	60/60/60	0.91 ± 0.22	1.08 ± 0.32	1.05 ± 0.16	1.61 ± 0.39	1.16 ± 0.15
Benzene	55/55/55	0.54 ± 0.10	0.30 ± 0.05	NA	0.46 ± 0.08	0.40 ± 0.04	58/58/58	0.47 ± 0.07	0.25 ± 0.03	0.21 ± 0.03	0.41 ± 0.06	0.34 ± 0.04
1,3-Butadiene	38/16/55	0.02 ± 0.02	0.01 ± 0.01	NA	0.03 ± 0.01	0.02 ± 0.01	34/2/58	0.02 ± 0.01	0.01 ± 0.01	0.01 ± 0.01	0.02 ± 0.01	0.02 ± <0.01
Carbon Tetrachloride	55/55/55	0.64 ± 0.03	0.65 ± 0.02	NA	0.63 ± 0.05	0.64 ± 0.02	58/58/58	0.54 ± 0.08	0.69 ± 0.04	0.62 ± 0.07	0.61 ± 0.03	0.62 ± 0.03
1,2-Dichloroethane	54/43/55	0.08 ± 0.01	0.07 ± 0.01	NA	0.07 ± 0.01	0.07 ± 0.01	49/46/58	0.08 ± 0.01	0.08 ± 0.01	0.04 ± 0.02	0.05 ± 0.02	0.06 ± 0.01
Formaldehyde	34/34/34	1.77 ± 0.33	NA	NA	1.37 ± 0.38	NA	60/60/60	1.56 ± 0.40	2.52 ± 0.89	3.53 ± 0.93	1.18 ± 0.30	2.16 ± 0.39
Elizabeth, New Jersey - ELNJ												
Acetaldehyde	60/60/60	1.78 ± 0.36	2.43 ± 0.58	3.11 ± 0.55	2.66 ± 0.78	2.49 ± 0.31	61/61/61	2.07 ± 0.53	2.82 ± 0.65	2.89 ± 0.34	2.23 ± 0.50	2.50 ± 0.26
Benzene	60/60/60	0.93 ± 0.17	0.67 ± 0.09	0.72 ± 0.11	0.95 ± 0.22	0.82 ± 0.08	60/60/60	0.94 ± 0.23	0.70 ± 0.14	0.69 ± 0.12	0.99 ± 0.20	0.83 ± 0.09
1,3-Butadiene	60/59/60	0.13 ± 0.04	0.11 ± 0.02	0.08 ± 0.01	0.15 ± 0.05	0.12 ± 0.02	60/52/60	0.14 ± 0.04	0.11 ± 0.02	0.10 ± 0.03	0.15 ± 0.05	0.12 ± 0.02
Carbon Tetrachloride	60/60/60	0.54 ± 0.08	0.62 ± 0.02	0.66 ± 0.04	0.64 ± 0.02	0.62 ± 0.03	60/60/60	0.57 ± 0.07	0.67 ± 0.04	0.63 ± 0.06	0.61 ± 0.04	0.62 ± 0.03
1,2-Dichloroethane	57/51/60	0.08 ± 0.01	0.08 ± 0.01	0.06 ± 0.01	0.08 ± 0.01	0.07 ± 0.01	55/52/60	0.09 ± 0.01	0.09 ± 0.01	0.05 ± 0.02	0.07 ± 0.02	0.08 ± 0.01
Ethylbenzene	60/60/60	0.21 ± 0.05	0.27 ± 0.05	0.26 ± 0.05	0.36 ± 0.11	0.28 ± 0.04	60/57/60	0.28 ± 0.11	0.28 ± 0.07	0.35 ± 0.09	0.38 ± 0.08	0.32 ± 0.04
Formaldehyde	60/60/60	2.32 ± 0.38	4.07 ± 1.33	6.94 ± 1.41	4.31 ± 1.13	4.38 ± 0.68	61/61/61	3.80 ± 0.72	4.81 ± 0.95	5.36 ± 0.76	3.81 ± 0.69	4.43 ± 0.41

NA = Not available because the criteria for calculating a quarterly and/or annual average were not met.
NS = Sampling was not conducted during this time.

Table 16-3. Quarterly and Annual Average Concentrations of the Pollutants of Interest for the New Jersey Monitoring Sites (Continued)

Pollutant	2015						2016					
	# of Detects/ # >MDL/ # Samples	Q1 Avg (µg/m³)	Q2 Avg (µg/m³)	Q3 Avg (µg/m³)	Q4 Avg (µg/m³)	Annual Average (µg/m³)	# of Detects/ # >MDL/ # Samples	Q1 Avg (µg/m³)	Q2 Avg (µg/m³)	Q3 Avg (µg/m³)	Q4 Avg (µg/m³)	Annual Average (µg/m³)
North Brunswick, New Jersey - NBNJ												
Acetaldehyde	59/59/59	1.38 ± 0.20	2.12 ± 0.43	2.49 ± 0.33	2.16 ± 0.46	2.03 ± 0.20	NS	NS	NS	NS	NS	NS
Benzene	59/59/59	0.75 ± 0.12	0.37 ± 0.06	0.44 ± 0.15	0.55 ± 0.13	0.53 ± 0.07	NS	NS	NS	NS	NS	NS
1,3-Butadiene	54/41/59	0.07 ± 0.02	0.03 ± 0.01	0.03 ± 0.01	0.06 ± 0.02	0.05 ± 0.01	NS	NS	NS	NS	NS	NS
Carbon Tetrachloride	59/59/59	0.61 ± 0.04	0.64 ± 0.03	0.65 ± 0.04	0.66 ± 0.02	0.64 ± 0.02	NS	NS	NS	NS	NS	NS
1,2-Dichloroethane	59/51/59	0.08 ± 0.01	0.07 ± 0.01	0.06 ± 0.01	0.08 ± 0.01	0.07 ± <0.01	NS	NS	NS	NS	NS	NS
Formaldehyde	59/59/59	2.34 ± 0.47	3.94 ± 1.12	5.34 ± 1.10	1.41 ± 0.31	3.29 ± 0.56	NS	NS	NS	NS	NS	NS
East Brunswick, New Jersey - NRNJ												
Acetaldehyde	NS	NS	NS	NS	NS	NS	60/60/60	1.13 ± 0.34	1.64 ± 0.37	2.05 ± 0.33	1.59 ± 0.43	1.59 ± 0.19
Benzene	NS	NS	NS	NS	NS	NS	60/60/60	0.71 ± 0.16	0.37 ± 0.06	0.35 ± 0.08	0.59 ± 0.13	0.51 ± 0.07
1,3-Butadiene	NS	NS	NS	NS	NS	NS	52/25/60	0.09 ± 0.03	0.05 ± 0.01	0.03 ± 0.02	0.07 ± 0.02	0.06 ± 0.01
Carbon Tetrachloride	NS	NS	NS	NS	NS	NS	60/60/60	0.59 ± 0.07	0.71 ± 0.04	0.59 ± 0.07	0.60 ± 0.06	0.62 ± 0.03
1,2-Dichloroethane	NS	NS	NS	NS	NS	NS	57/55/60	0.09 ± 0.01	0.10 ± 0.01	0.06 ± 0.01	0.07 ± 0.01	0.08 ± 0.01
Formaldehyde	NS	NS	NS	NS	NS	NS	60/60/60	1.47 ± 0.30	2.83 ± 0.66	3.52 ± 0.43	2.03 ± 0.42	2.44 ± 0.30
Hexachloro-1,3-butadiene	NS	NS	NS	NS	NS	NS	17/0/60	0.01 ± 0.02	0.04 ± 0.03	0.03 ± 0.03	0.03 ± 0.03	0.03 ± 0.01

NA = Not available because the criteria for calculating a quarterly and/or annual average were not met.
NS = Sampling was not conducted during this time.

Observations for CSNJ from Table 16-3 include the following:

- The pollutants of interest with the highest annual average concentrations are formaldehyde and acetaldehyde; these are the only two pollutants with annual average concentrations greater than 1 $\mu g/m^3$. Of the VOCs, bromomethane has the highest annual average concentration for 2015 (0.93 ± 0.74 $\mu g/m^3$) while benzene has the highest annual average for 2016 (0.74 ± 0.11 $\mu g/m^3$).

- The quarterly average concentrations of formaldehyde calculated for 2015 (which range from 2.05 ± 0.26 $\mu g/m^3$ for the first quarter to 5.48 ± 0.77 $\mu g/m^3$ for the third quarter) span a wider range than those calculated for 2016 (which range from 3.62 ± 0.84 $\mu g/m^3$ for the first quarter to 4.57 ± 1.00 $\mu g/m^3$ for the third quarter). The first quarter average concentration for 2015 is significantly less than all of the other quarterly average concentrations shown. Formaldehyde concentrations measured at CSNJ range from 0.954 $\mu g/m^3$ to 8.81 $\mu g/m^3$. Formaldehyde concentrations greater than 4 $\mu g/m^3$ were not measured at CSNJ during the first quarter of 2015, the only calendar quarter for which this is true. Further, only one formaldehyde concentration greater than 3 $\mu g/m^3$ was measured at CSNJ between January and March 2015; for most other calendar quarters, formaldehyde concentrations greater than 3 $\mu g/m^3$ account for the majority of measurements (the exception is the fourth quarter of 2015, although concentrations of this magnitude still accounted for more than 40 percent of the measurements).

- Concentrations of acetaldehyde appear higher in 2016 than in 2015, based on the quarterly and annual average concentrations shown in Table 16-3, although there is considerable variability within the measurements. Acetaldehyde concentrations measured at CSNJ range from 0.287 $\mu g/m^3$ to 8.18 $\mu g/m^3$. Of the 13 acetaldehyde concentrations greater than 3.5 $\mu g/m^3$, only two were measured in 2015, compared to 11 in 2016. The maximum acetaldehyde concentration was measured on July 17, 2016 and another concentration of similar magnitude was also measured on the next sample day. CSNJ is one of four NMP sites at which an acetaldehyde concentration greater than 8 $\mu g/m^3$ was measured. The minimum acetaldehyde concentration was also measured at CSNJ in July 2016. This explains the large confidence interval associated with the third quarter average concentration for 2016.

- Among the VOC pollutants of interest, bromomethane has the highest annual average concentration for 2015 (0.93 ± 0.74 $\mu g/m^3$). The annual average for 2016 is less (0.41 ± 0.24 $\mu g/m^3$), although both exhibit a relatively high-level of variability (particularly 2015). Concentrations of bromomethane measured at CSNJ range from 0.0311 $\mu g/m^3$ to 20.0 $\mu g/m^3$. Seventeen of the 18 bromomethane concentrations greater than 1 $\mu g/m^3$ measured across the program were measured at CSNJ, with all 10 concentrations greater than 2 $\mu g/m^3$ measured at CSNJ. The two highest concentrations (20.0 $\mu g/m^3$ and 10.2 $\mu g/m^3$) were both measured in April 2015, explaining at least in part, the high quarterly average and even higher confidence interval for the second quarter of 2015. In fact, of the 17 bromomethane concentrations greater than 1 $\mu g/m^3$ measured at this site, all but one was measured during January, February, March, or April of either year, with most of these measured in March or April. Bromomethane concentrations greater than 0.4 $\mu g/m^3$ were not measured at CSNJ during the second half of either year.

- Benzene has the highest annual average concentration for 2016 among the VOC pollutants of interest. Concentrations of benzene measured at CSNJ range from 0.263 µg/m^3 to 3.97 µg/m^3. Of the 23 benzene concentrations greater than 1 µg/m^3 measured at CSNJ, all but one were measured during the first or fourth quarters of either year. Conversely, 19 of the 20 lowest benzene concentrations measured at CSNJ were measured during the second or third quarters. This explains the differences shown in the quarterly average benzene concentrations, even though the differences are not statistically significant.

- A similar tendency is shown for 1,3-butadiene. Of the 28 1,3-butadiene concentrations greater than 0.1 µg/m^3 measured at CSNJ, only four were measured outside the first or fourth quarters (two each year).

- Ethylbenzene concentrations measured at CSNJ range from 0.104 µg/m^3 to 1.67 µg/m^3, which is among the highest ethylbenzene concentrations measured across the program. For 2016, the third and fourth quarter average concentrations of ethylbenzene are twice the first and second quarter average concentrations. A review of CSNJ's ethylbenzene data shows that four of the five ethylbenzene concentrations greater than 1 µg/m^3 were measured at CSNJ during the second half of 2016 (with the exception measured during the second half of 2015). Conversely, only one ethylbenzene concentration less than 0.2 µg/m^3 was measured during the second half of 2016, compared to 13 during the first half of the year.

Observations for CHNJ from Table 16-3 include the following:

- As described in Section 2.4, carbonyl compound samples collected at CHNJ between March 31, 2015 and September 3, 2015 were invalidated due to contamination issues with the collection system. As a result, second quarter, third quarter, and annual average concentrations for 2015 could not be calculated. Formaldehyde and acetaldehyde have the highest available quarterly averages shown for 2015, though, based on available quarterly averages, and have the highest quarterly and annual averages for 2016, among the pollutants of interest for CHNJ.

- Based on 2016 data, "higher" formaldehyde concentrations were more often measured during the warmer months of the year. Concentrations of formaldehyde measured at CHNJ in 2016 range from 0.174 µg/m^3 to 7.27 µg/m^3, with all 11 concentrations of at least 3.5 µg/m^3 measured at CHNJ between May and August.

- Concentrations of acetaldehyde measured at CHNJ in 2016 range from 0.146 µg/m^3 to 3.30 µg/m^3. The three highest acetaldehyde concentrations measured at CHNJ were measured on sample days in November. Further, half of the 14 acetaldehyde concentrations greater than 1.5 µg/m^3 were measured in either November or December. This helps explain the higher quarterly average calculated for the fourth quarter of 2016 compared to the other quarterly average concentrations for 2016.

- A number of intermittent issues with the collection system experienced throughout the third quarter of 2015 resulted in too many invalidated VOC samples for a quarterly average concentration to be calculated.

- Among the VOCs, carbon tetrachloride has the highest annual average concentrations. Concentrations of carbon tetrachloride measured at CHNJ range from 0.126 μg/m^3 to 0.851 μg/m^3, although most concentrations fell between 0.5 μg/m^3 and 0.75 μg/m^3. The minimum carbon tetrachloride concentration measured at CHNJ ties with another concentration of the same magnitude for the second lowest carbon tetrachloride concentration measured at an NMP site in 2015 and 2016.

- CHNJ is the only NMP site at which at a benzene concentration of at least 1 μg/m^3 was not measured. CHNJ has the lowest quarterly average concentration of benzene (0.21 ± 0.03 μg/m^3, third quarter 2016) and the lowest annual average concentration of benzene (0.34 ± 0.04 μg/m^3, 2016) among NMP sites sampling this pollutant.

Observations for ELNJ from Table 16-3 include the following:

- The annual average concentrations for the pollutants of interest for ELNJ are similar across the two years of sampling.

- The pollutants of interest with the highest annual average concentrations are formaldehyde and acetaldehyde. These are the only two pollutants with annual average concentrations greater than 1 μg/m^3. Of the VOCs, benzene has the highest annual average concentrations.

- The first quarter average concentration of formaldehyde for 2015 is significantly less than the other quarterly averages for 2015, each of which has a relatively large confidence interval. The first quarter average concentration for 2015 is also significantly less than each of the quarterly average concentrations for 2016. A review of the data shows that formaldehyde concentrations measured at ELNJ range from 0.932 μg/m^3 to 12.6 μg/m^3. The number of formaldehyde concentrations less than 2 μg/m^3 measured during the first quarter of 2015 (8) is twice the number measured during the rest of the calendar quarters combined (4). Further, none of the 61 formaldehyde concentrations greater than 4 μg/m^3 were measured during the first quarter of 2015, but range in number from five (the second quarter of 2015) to 13 (third quarter of both years) for the remaining calendar quarters.

- The first quarter average concentration of acetaldehyde for 2015 is also lower than the other quarterly averages calculated for this site, although the difference is less pronounced. Acetaldehyde concentrations measured at ELNJ span an order of magnitude, ranging from 0.650 μg/m^3 to 6.07 μg/m^3. None of the 35 formaldehyde concentrations greater than or equal to 3 μg/m^3 were measured during the first quarter of 2015, but range in number from three (the second quarter of 2015) to seven (third quarter of both years) for the remaining calendar quarters.

- Benzene concentrations measured at ELNJ range from 0.320 μg/m^3 to 2.06 μg/m^3. Benzene concentrations measured at ELNJ appear to be higher during the colder months of the year and lower during the warmer months of the year, based on the quarterly average concentrations. Few of the benzene concentrations greater than 1 μg/m^3 measured at ELNJ were measured outside the first or fourth quarters of the year; of the 29 benzene concentrations greater than 1 μg/m^3, only five were not measured between January and March or October and December. However,

confidence intervals indicate that the difference among the quarterly average concentrations is not statistically significant.

Observations for NBNJ and NRNJ from Table 16-3 include the following:

- The instrumentation at NBNJ was moved to NRNJ at the end of 2015, where sampling resumed. Thus, quarterly and annual average concentrations are available for NBNJ for 2015 and for NRNJ for 2016.

- For the VOCs, the annual average concentrations are similar between the two sampling locations. Carbonyl compounds exhibit considerable differences, particularly acetaldehyde.

- Concentrations of acetaldehyde measured at NBNJ in 2015 range from 0.753 $\mu g/m^3$ to 4.03 $\mu g/m^3$, while concentrations of acetaldehyde measured at NRNJ in 2016 range from 0.660 $\mu g/m^3$ to 5.26 $\mu g/m^3$. Even though a wider range of concentrations was measured at NRNJ, acetaldehyde concentrations greater than 2 $\mu g/m^3$ account for nearly half of the measurements at NBNJ, but account for less than one-third of the measurements at NRNJ. At the other end of the concentration range, the number of acetaldehyde concentrations less than 1 $\mu g/m^3$ measured at NRNJ (15) is three times the number measured at NBNJ (5).

- Concentrations of formaldehyde measured at NBNJ in 2015 range from 0.530 $\mu g/m^3$ to 10.1 $\mu g/m^3$, while concentrations of formaldehyde measured at NRNJ in 2016 range from 0.491 $\mu g/m^3$ to 3.57 $\mu g/m^3$. Eight formaldehyde concentrations greater than 5 $\mu g/m^3$ were measured at NBNJ, while only two were measured at NRNJ.

- The VOCs with the highest annual average concentrations for NBNJ and NRNJ are the same: carbon tetrachloride and benzene.

- The first and fourth quarter average concentrations of benzene for NRNJ are significantly higher than the other quarterly averages. Benzene concentrations measured at NRNJ range from 0.214 $\mu g/m^3$ to 1.54 $\mu g/m^3$. A review of the data shows that all but one of the 10 benzene concentrations greater than 0.75 $\mu g/m^3$ were measured at NBNJ between January and March or October and December, including the three greater than 1 $\mu g/m^3$. A similar observation can be made for NBNJ, although the differences among the quarter averages is not statistically significant.

Tables 4-10 through 4-13 present the NMP sites with the 10 highest annual average concentrations for each of the program-level pollutants of interest. Observations for the New Jersey sites from those tables include the following:

- The New Jersey sites appear in Table 4-10 for VOCs a total of several times (CSNJ, four times; ELNJ, twice; and NRNJ, once).

- Two New Jersey sites appear in Table 4-10 for hexachloro-1,3-butadiene, with the 2016 annual averages for NRNJ and CSNJ ranking fourth and ninth, respectively, for this pollutant. Note that annual average concentrations of this pollutant vary by about 0.04 $\mu g/m^3$ across the program. (Much of the 2015 hexachloro-1,3-butadiene data

was invalidated due to contamination of a laboratory internal standard, as described in Section 2.4, and thus, there are no 2015 annual averages for this pollutant.)

- CSNJ's annual average concentrations of ethylbenzene both appear among those sites with the highest annual averages of this pollutant, ranking sixth (2016) and eighth (2015). This site also has one of the highest annual averages of *p*-dichlorobenzene, ranking ninth for its 2016 annual average.

- ELNJ's annual average concentrations of 1,3-butadiene both appear among those sites with the highest annual averages of this pollutant, ranking seventh (2016) and ninth (2015).

- CSNJ, ELNJ, and NBNJ both appear in Table 4-11 for the carbonyl compounds. ELNJ has the sixth (2016) and seventh (2015) highest annual average concentrations of acetaldehyde and formaldehyde among NMP sites sampling these pollutants. CSNJ's 2016 annual averages of these two pollutants also appear in Table 4-11, ranking fourth for acetaldehyde and eighth for formaldehyde. In addition, NBNJ's annual average concentration of acetaldehyde for 2015 ranks tenth among NMP sites sampling this pollutant.

16.3.2 Concentration Comparison

In order to better illustrate how each site's annual average concentrations compare to the program-level averages, a site-specific box plot was created for each of the site-specific pollutants of interest, where applicable. Thus, box plots were created for each of the pollutants listed in Table 16-3 for each of the New Jersey sites. Figures 16-9 through 16-18 overlay the sites' minimum, annual average, and maximum concentrations for each year onto the program-level minimum, first quartile, median, average, third quartile, and maximum concentrations, as described in Section 3.4.2.1, and are discussed below. If an annual average concentration could not be calculated, the range of concentrations are still provided in the figures that follow.

Figure 16-9. Program vs. Site-Specific Average Acetaldehyde Concentrations

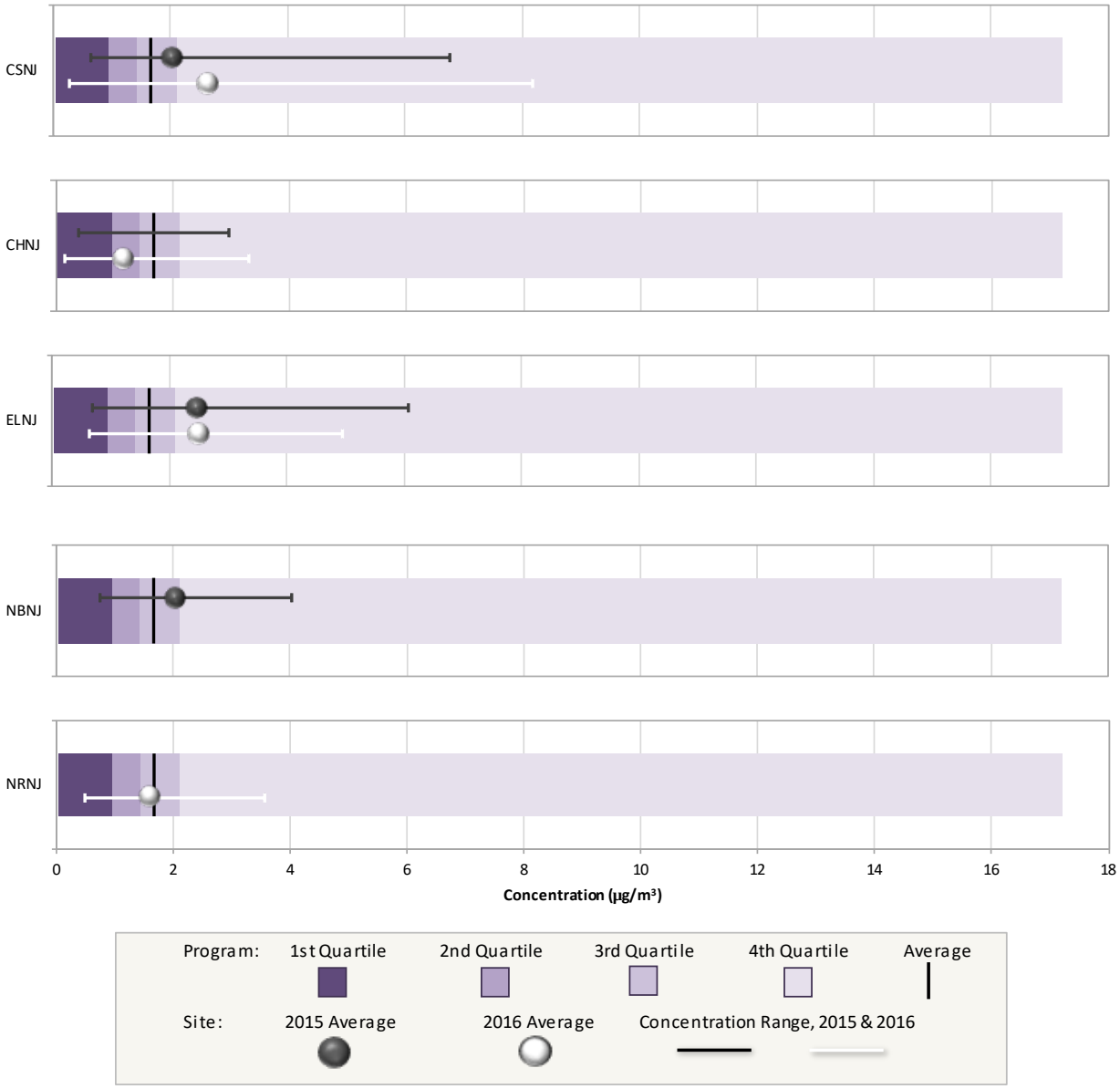


Figure 16-9 presents the box plots for acetaldehyde for the New Jersey sites and shows the following:

- All of the acetaldehyde concentrations measured at the New Jersey sites are considerably less than the program-level maximum concentration (17.2 µg/m^3). Among the New Jersey sites, the range of acetaldehyde concentrations is largest for CSNJ (2016) and smallest for CHNJ (2015), although half of this site's measurements were invalidated.

- The annual average concentrations for CSNJ and ELNJ are greater than the program-level average concentration (1.67 µg/m^3). This is also true for NBNJ's annual average concentration for 2015. NRNJ's annual average for 2016 is similar to the program-

level average while the annual average for CHNJ is less than the program-level average and median concentrations.

- An annual average concentration for CHNJ for 2015 could not be calculated. The site relocation from NBNJ to NRNJ results in one annual average for each of these sites.

Figure 16-10. Program vs. Site-Specific Average Benzene Concentrations

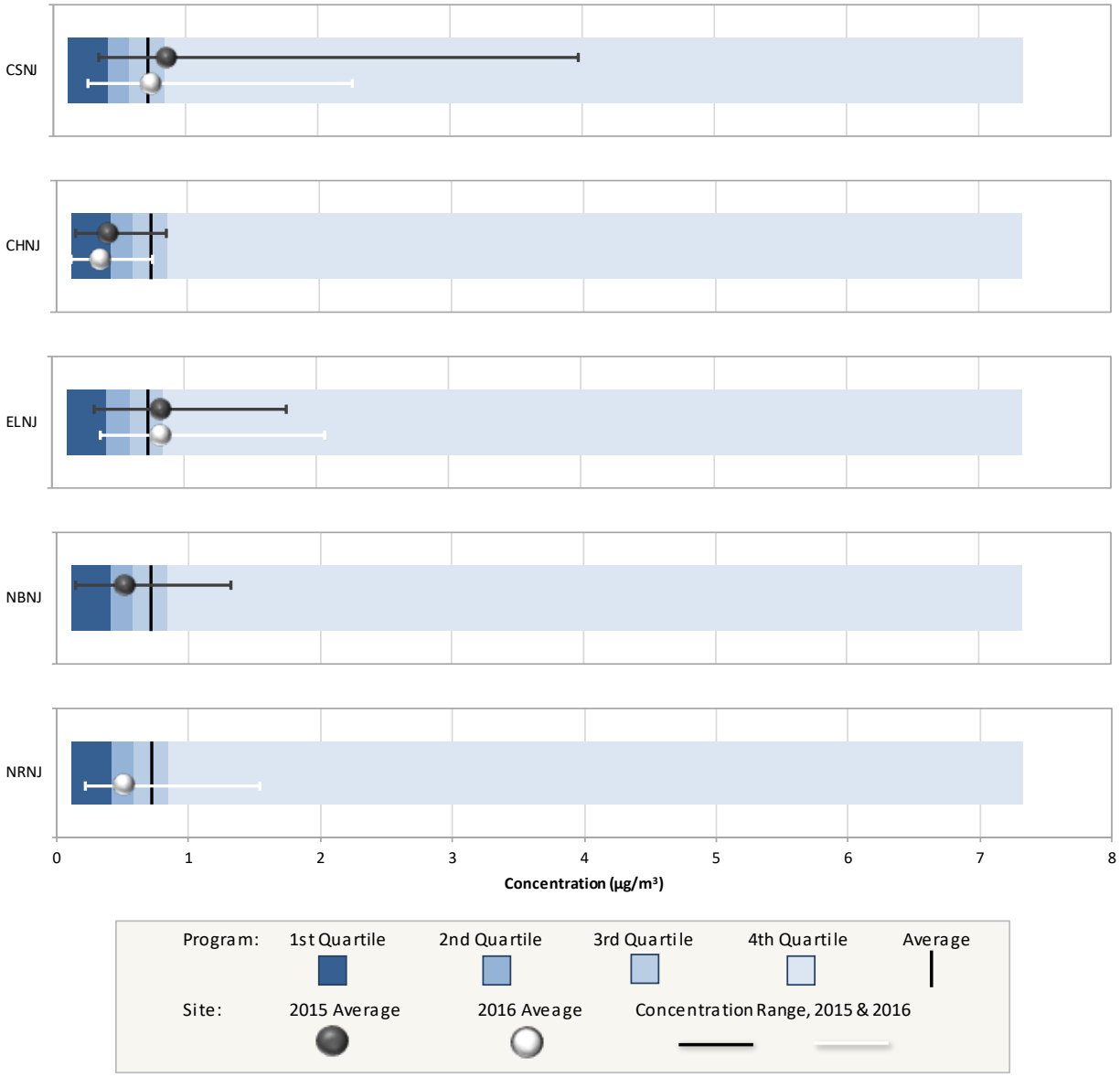


Figure 16-10 presents the box plots for benzene for the New Jersey sites and shows the following:

- The maximum benzene concentration measured at a New Jersey site was measured at CSNJ (3.97 µg/m^3), which is among the higher benzene concentrations measured across the program.

- The range of benzene concentrations measured was largest for CSNJ and smallest for CHNJ. The minimum benzene concentration measured across the program was measured at CHNJ and the entire range of benzene concentrations measured at this site is less than the program-level third quartile (0.85 µg/m^3).

- The annual average concentrations of benzene for ELNJ and CSNJ are similar to or greater than the program-level average concentration (0.72 µg/m^3), while the available annual averages for the remaining New Jersey sites are less than the program-level average and median concentrations.

Figure 16-11. Program vs. Site-Specific Average Bromomethane Concentrations

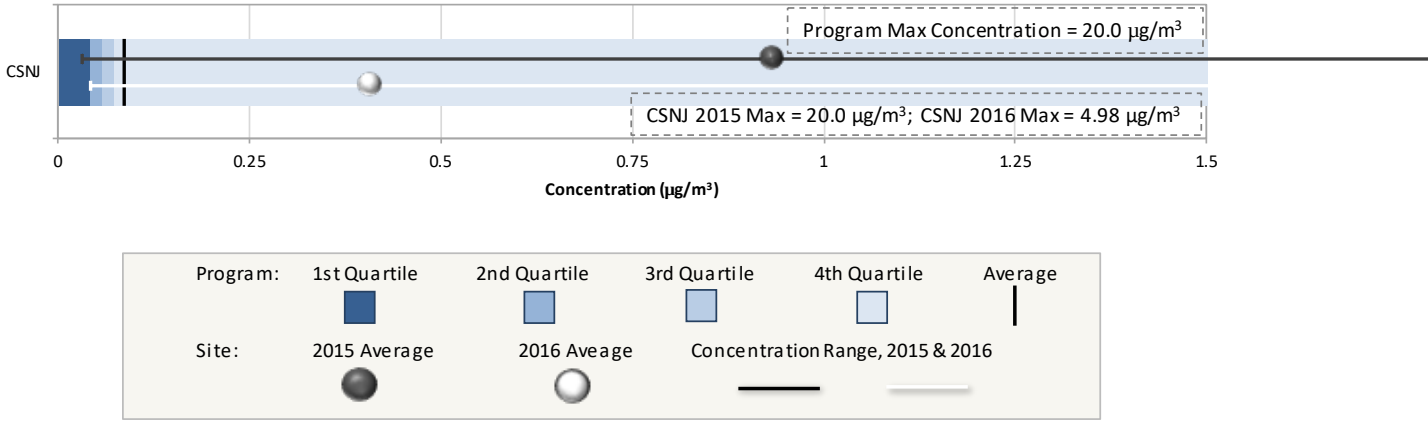


Figure 16-11 presents the box plot for bromomethane for CSNJ and shows the following:

- This figure presents the box plot for bromomethane for CSNJ, the only New Jersey site for which this pollutant was identified as a pollutant of interest. CSNJ is the only NMP site for which bromomethane was identified as a pollutant of interest.

- The program-level maximum bromomethane concentration (20.0 µg/m^3) is not shown directly on the box plot in Figure 16-11 because the scale of the box plot would be too large to readily observe data points at the lower end of the concentration range. Thus, the scale of the box plot has been reduced to 1.5 µg/m^3. Also, since the maximum bromomethane concentration measured each year at CSNJ is greater than the scale of the box plot, the site-specific maximum concentrations are labeled.

- Nineteen of the 20 highest concentrations of bromomethane measured across the program were measured at CSNJ.

- Although the annual average concentration of bromomethane for 2015 is more than twice the annual average for 2016, both are considerably greater than program-level average concentration (0.087 µg/m^3). CSNJ is the only NMP site with an annual average concentration of bromomethane greater than 0.1 µg/m^3.

Figure 16-12. Program vs. Site-Specific Average 1,3-Butadiene Concentrations

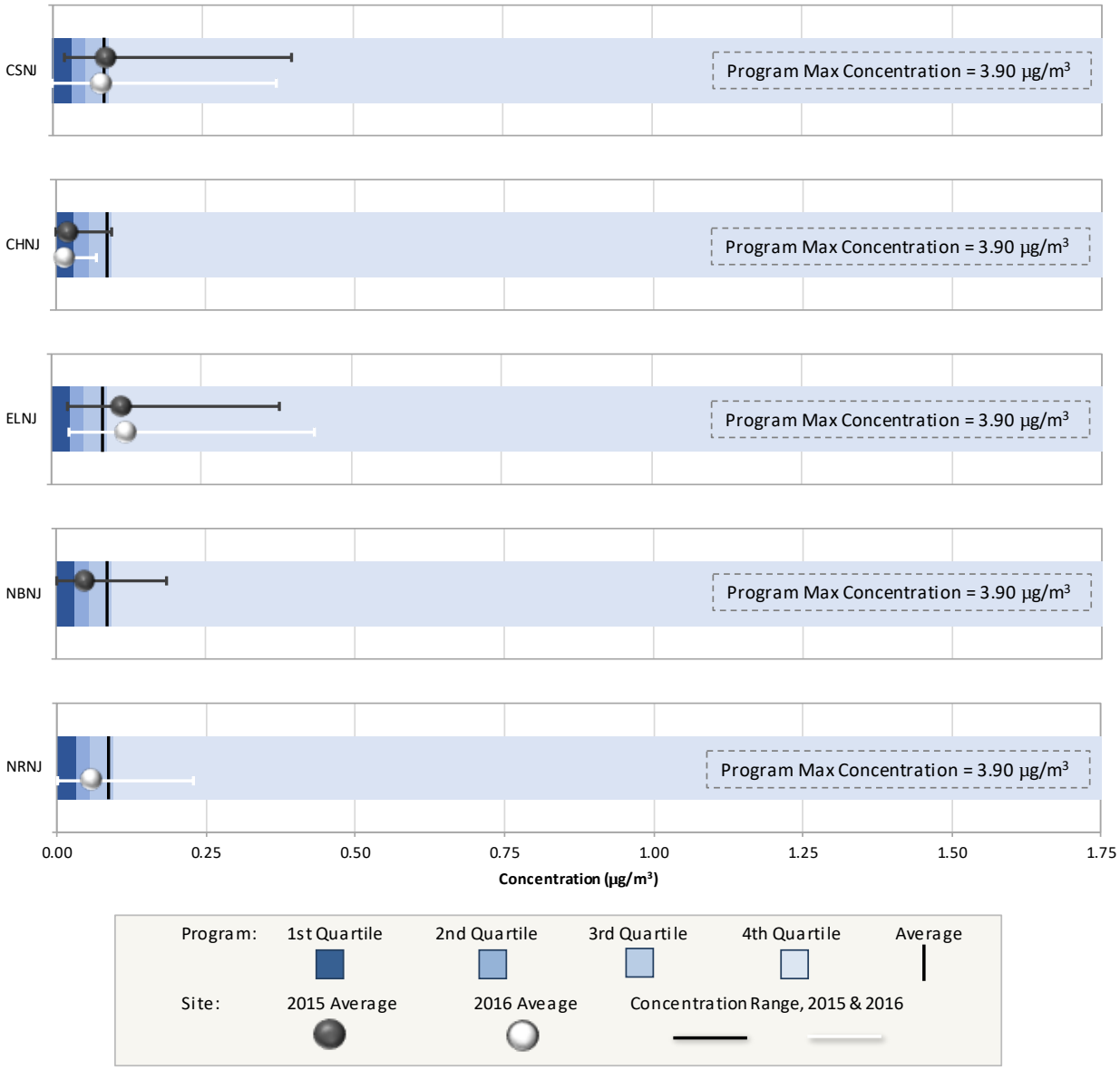


Figure 16-12 presents the box plots for 1,3-butadiene for the New Jersey sites and shows the following:

- The program-level maximum 1,3-butadiene concentration (3.90 µg/m^3) is not shown directly on the box plots in Figure 16-12 as the scale has also been reduced to allow for the observation of data points at the lower end of the concentration range.

- All of the 1,3-butadiene concentrations measured at the New Jersey sites are less than 0.45 µg/m^3. A few non-detects were measured at each site, with the exception of ELNJ. The minimum concentration measured each year at ELNJ is just less than the program-level first quartile (0.03 µg/m^3).

- Both annual average concentrations of 1,3-butadiene for ELNJ are greater than the program-level average concentration (0.086 µg/m^3), while the annual averages for CSNJ are similar to the program-level average. The available annual averages for NBNJ and NRNJ are similar to the program-level median concentration while both annual averages for CHNJ are less than the program-level first quartile. CHNJ's 2016 annual average concentration is the lowest annual average of 1,3-butadiene among all NMP sites sampling VOCs.

Figure 16-13. Program vs. Site-Specific Average Carbon Tetrachloride Concentrations

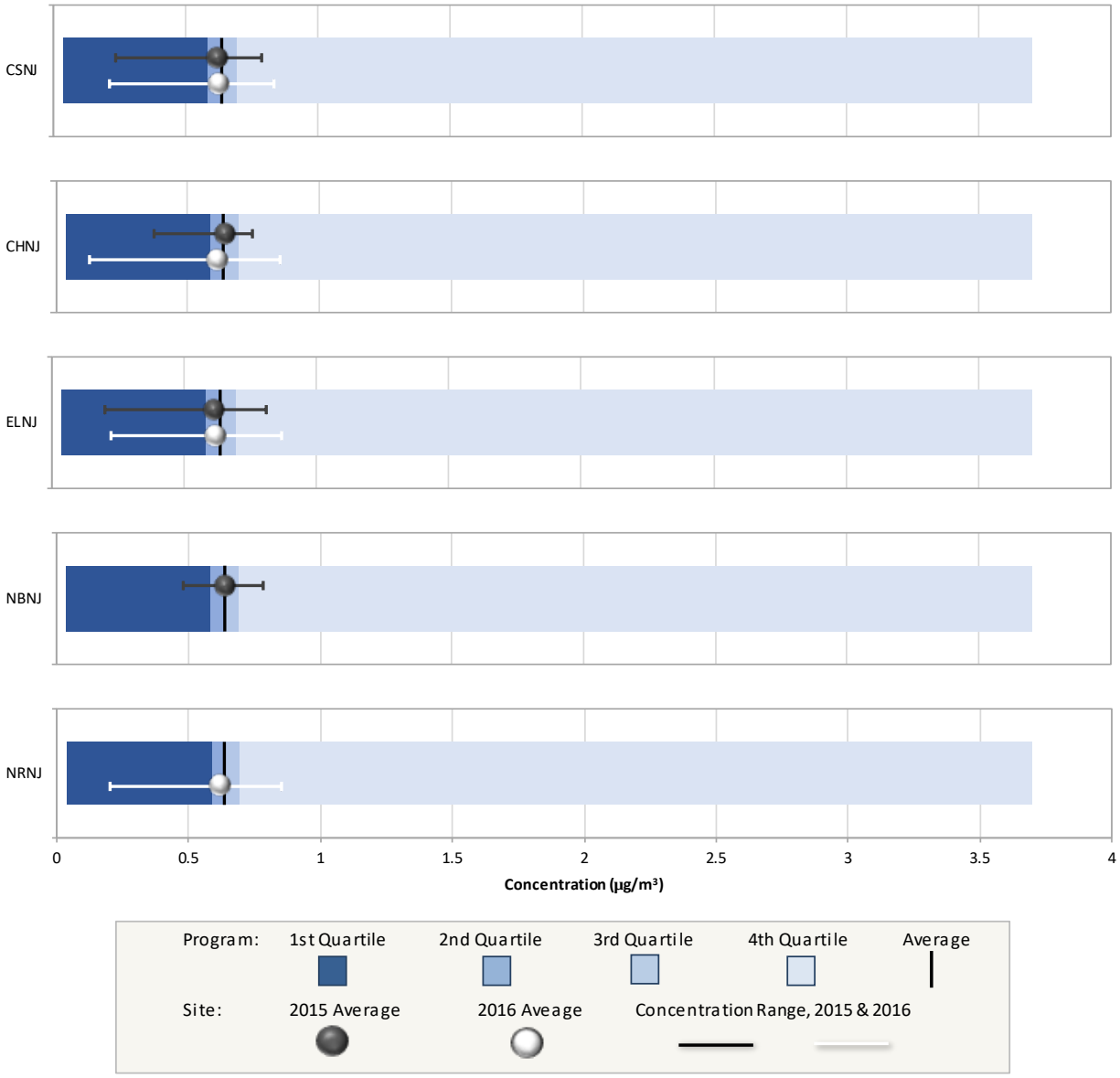


Figure 16-13 presents the box plots for carbon tetrachloride for the New Jersey sites and shows the following:

- Carbon tetrachloride concentrations measured at these sites range from 0.126 µg/m^3 and 0.870 µg/m^3, though relatively few measurements outside the 0.25 µg/m^3 to 0.80 µg/m^3 range were measured. Though the maximum concentration measured at NBNJ is not much different than the other sites, it's the minimum concentration that gives this site its compressed range. Only one concentration less than 0.5 µg/m^3 was measured at NBNJ, with the number ranging from seven to 11 for the other New Jersey sites.

- The annual average concentrations of carbon tetrachloride for the New Jersey sites are similar to each other, ranging from 0.62 µg/m^3 and 0.64 µg/m^3, with each falling on either side of the program-level average concentration of 0.63 µg/m^3.

Figure 16-14. Program vs. Site-Specific Average *p*-Dichlorobenzene Concentrations

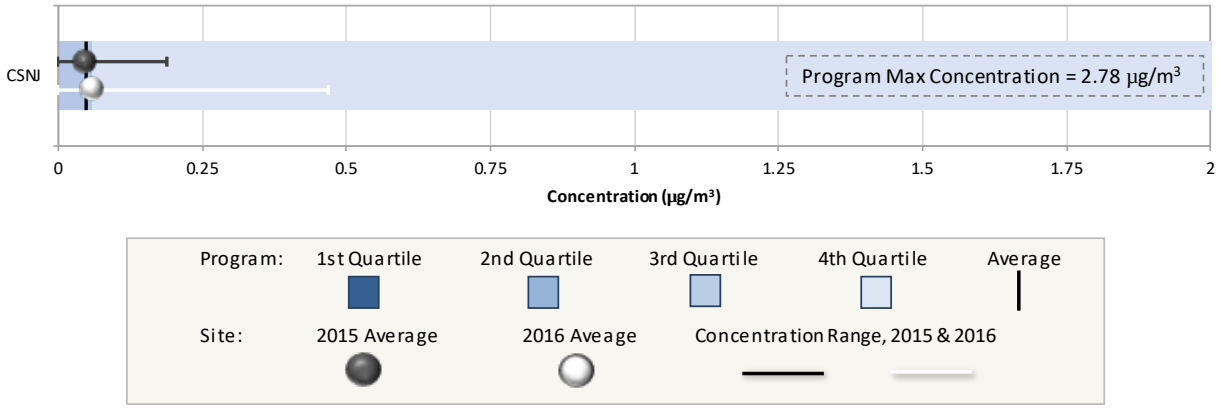


Figure 16-14 presents the box plot for *p*-dichlorobenzene for CSNJ and shows the following:

- CSNJ is the only New Jersey site for which *p*-dichlorobenzene was identified as a pollutant of interest.

- Similar to other pollutants, the program-level maximum *p*-dichlorobenzene concentration (2.78 µg/m^3) is not shown directly on the box plot as the scale of the box plot has been reduced to allow for the observation of data points at the lower end of the concentration range. Note that the program-level first and second quartiles are zero for this pollutant, indicating that at least 50 percent of the measurements across the program are non-detects and thus, are not visible on the box plot.

- The maximum *p*-dichlorobenzene concentration measured at CSNJ (0.470 µg/m^3) is considerably less than the maximum concentration measured across the program.

- CSNJ's annual average concentration for 2015 is similar to the program-level average, while the annual average for 2016 is slightly higher.

Figure 16-15. Program vs. Site-Specific Average 1,2-Dichloroethane Concentrations

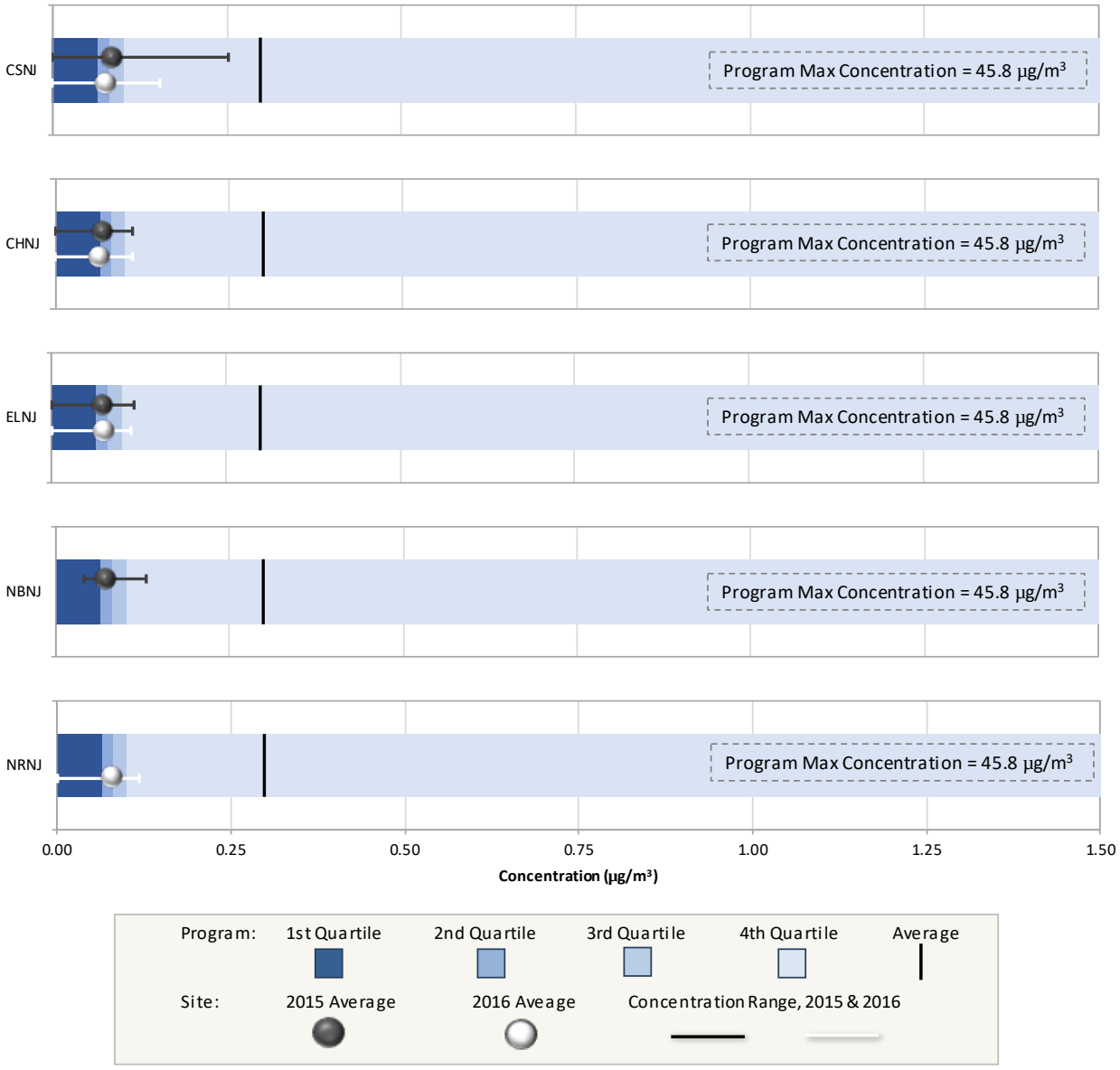


Figure 16-15 presents the box plots for 1,2-dichloroethane for the New Jersey sites and shows the following:

- The scale of the box plots in Figure 16-15 has also been reduced to allow for the observation of data points at the lower end of the concentration range, as the program-level maximum 1,2-dichloroethane concentration (45.8 µg/m^3) is considerably greater than the majority of measurements.

- The maximum concentration of 1,2-dichloroethane measured at a New Jersey site is 0.251 µg/m^3, which is less than the program-level average concentration of 0.30 µg/m^3, which is being driven by the measurements at the upper end of the concentration range.

- The annual average concentrations for the New Jersey sites are less than 0.1 µg/m^3, with most of them less than the program-level median concentration (0.081 µg/m^3).

Figure 16-16. Program vs. Site-Specific Average Ethylbenzene Concentrations

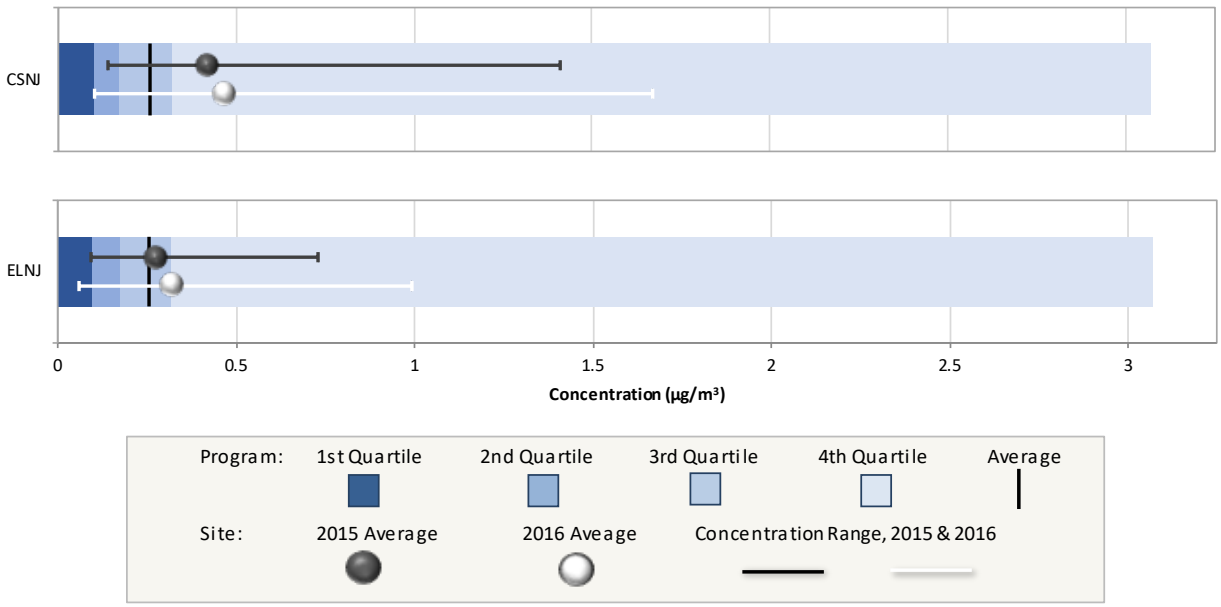


Figure 16-16 presents the box plots for ethylbenzene for CSNJ and ELNJ and shows the following:

- This figure presents the box plots for CSNJ and ELNJ, the New Jersey sites for which ethylbenzene was identified as a pollutant of interest.

- The range of ethylbenzene concentrations was larger for CSNJ than ELNJ.

- Ethylbenzene concentrations less than 0.1 µg/m^3 were not measured at CSNJ. The minimum ethylbenzene concentration measured at CSNJ in 2015 and 2016 are both greater than the program-level first quartile.

- The annual average concentrations for CSNJ are both greater than the program-level average (0.26 µg/m^3) and third quartile (0.32 µg/m^3). The annual average concentrations for ELNJ are less than those calculated CSNJ, with the annual average for 2015 similar to the program-level average and the annual average for 2016 similar to the program-level average third quartile.

Figure 16-17. Program vs. Site-Specific Average Formaldehyde Concentrations

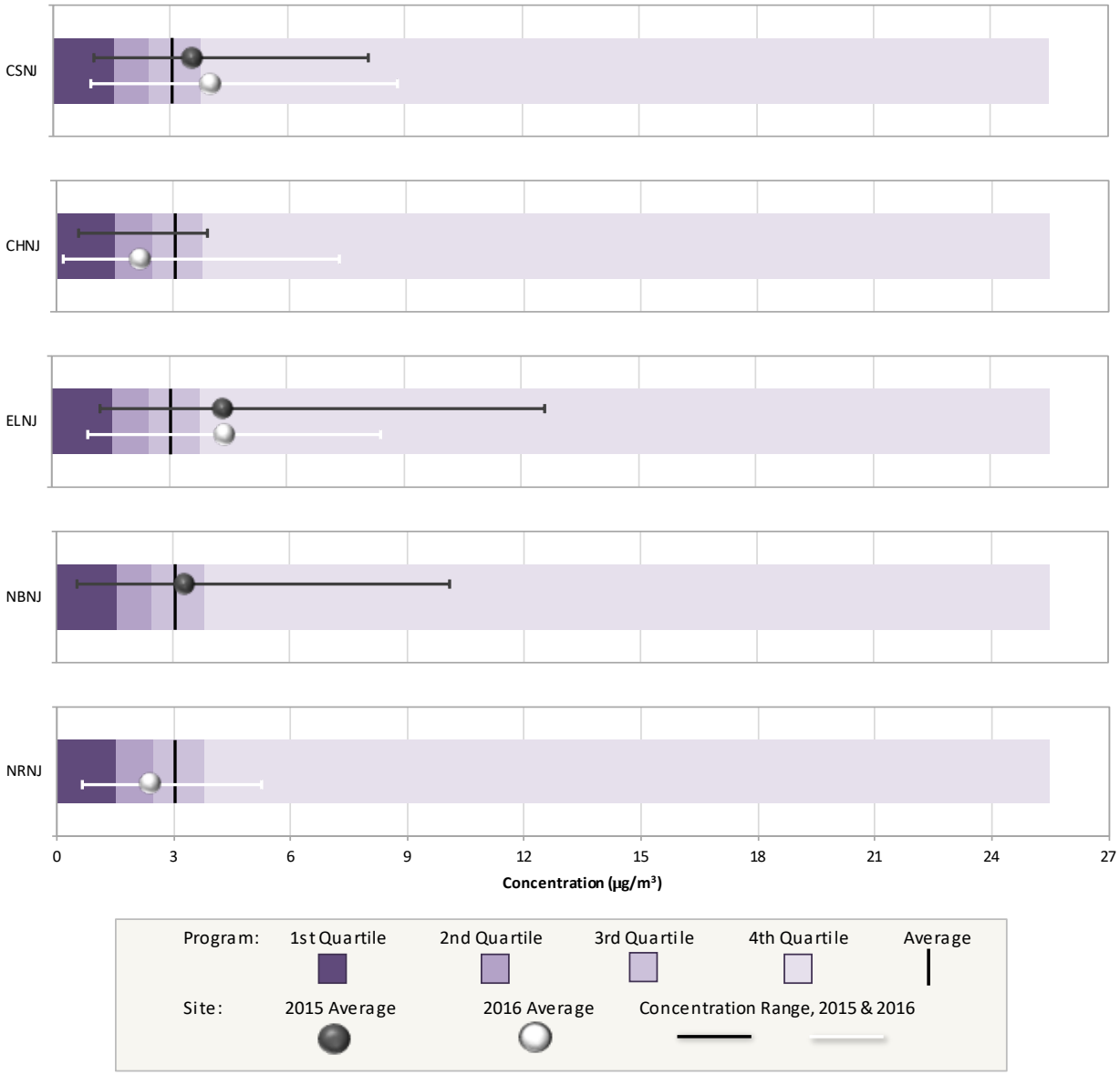


Figure 16-17 presents the box plots for formaldehyde for the New Jersey sites and shows the following:

- Among the New Jersey sites, the maximum formaldehyde concentration was measured at ELNJ, although this measurement is half the magnitude of the program-level maximum concentration.

- The annual average concentrations of formaldehyde for ELNJ are similar to each other and both are greater than the program-level average and third quartile. The annual averages for CSNJ fall on either side of the program-level third quartile (3.78 µg/m^3). NBNJ's annual average concentration for 2015 falls between the program-level average (3.05 µg/m^3) and third quartile. The available annual averages for CHNJ and NRNJ are both less than the program-level average concentration.

Figure 16-18. Program vs. Site-Specific Average Hexachloro-1,3-butadiene Concentrations

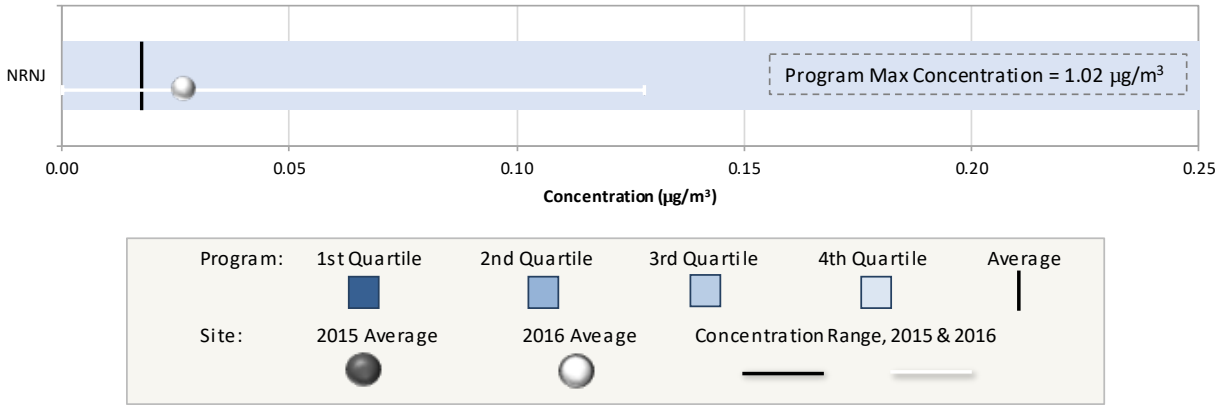


Figure 16-18 presents the box plots for hexachloro-1,3-butadiene for the New Jersey sites and shows the following:

- NRNJ is the only New Jersey site for which hexachloro-1,3-butadiene was identified as a pollutant of interest.

- The scale of this box plot has also been reduced, as the program-level maximum hexachloro-1,3-butadiene concentration (1.02 µg/m^3) is an order of magnitude higher than the next highest concentration measured (0.150 µg/m^3). Note that the first, second, and third quartiles for hexachloro-1,3-butadiene are zero at the program-level (and therefore not visible on the box plot) due to the large number of non-detects.

- Hexachloro-1,3-butadiene was detected in just over one-quarter of the samples collected at NRNJ in 2016, although none of these were above the MDL for this pollutant.

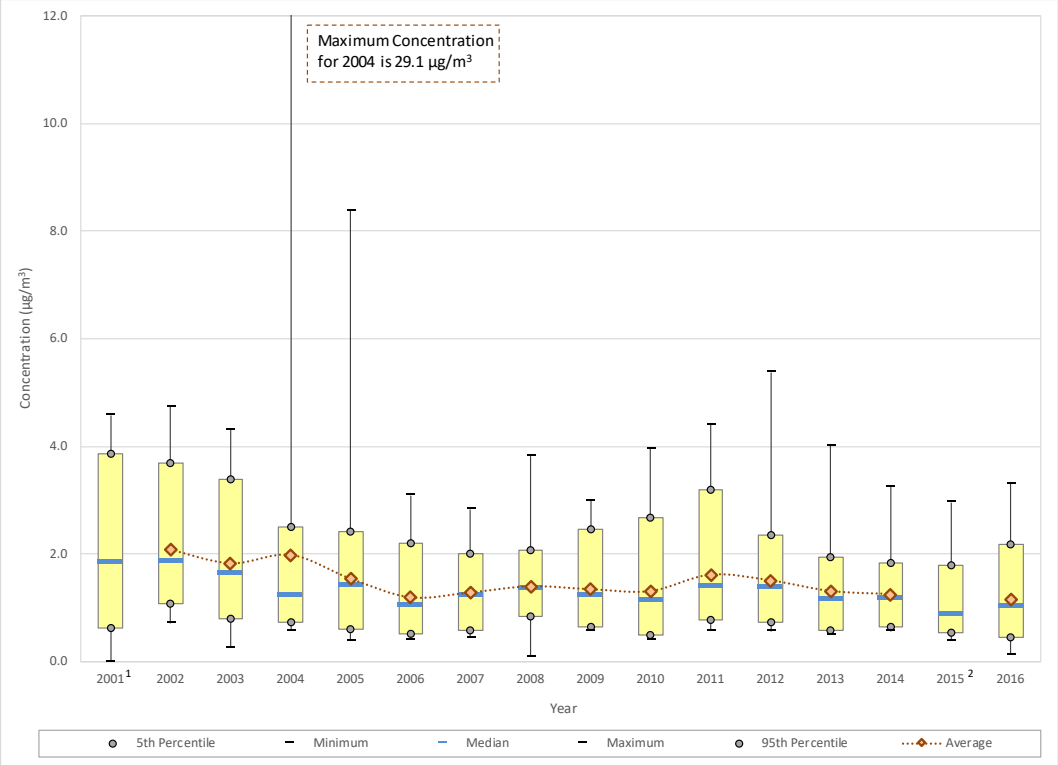
- The annual average hexachloro-1,3-butadiene concentration for NRNJ is just slightly greater than the program-level average concentration (0.017 µg/m^3). NRNJ has the fourth highest annual average concentration of hexachloro-1,3-butadiene among NMP sites sampling this pollutant.

16.3.3 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the pollutants of interest for 5 consecutive years or longer, as described in Section 3.4.2.2. CHNJ, ELNJ, and NBNJ have sampled VOCs and carbonyl compounds under the NMP for many years. ELNJ has sampled under the NMP since 2000 and CHNJ and NBNJ since 2001. Thus, Figures 16-19 through 16-37 present the 1-year statistical metrics for each of the pollutants of interest first for CHNJ, then for ELNJ and NBNJ (through 2015 for this site). The statistical metrics presented for assessing trends include the substitution of zeros for non-detects. If sampling began mid-year, a minimum of 6 months of sampling is required for inclusion in the

trends analysis; in these cases, a 1-year average concentration is not provided, although the range and percentiles are still presented. CSNJ began sampling under the NMP is 2013; thus, a trends analysis was not performed for this site. Similarly, a trends analysis was not performed for NRNJ.

Figure 16-19. Yearly Statistical Metrics for Acetaldehyde Concentrations Measured at CHNJ



[1] A 1-year average is not presented because sampling under the NMP did not begin until May 2001.
[2]A 1-year average is not presented due to a contamination issue with the collection system in 2015.

Observations from Figure 16-19 for acetaldehyde concentrations measured at CHNJ include the following:

- Sampling for carbonyl compounds under the NMP began at CHNJ in May 2001. Because a full year's worth of data is not available for 2001, a 1-year average concentration is not presented, although the range of measurements is provided. In addition, a 1-year average concentration could not be calculated for 2015 due to collection system contamination issues resulting in the invalidation of a large number of samples collected in 2015.

- The two highest acetaldehyde concentrations were measured at CHNJ in 2004 (29.1 µg/m^3 and 11.5 µg/m^3). All other concentrations measured in 2004 were less than 3 µg/m^3. Two additional acetaldehyde concentrations greater than 5 µg/m^3 have been measured at CHNJ, one in 2005 (8.38 µg/m^3) and one in 2012 (5.38 µg/m^3).

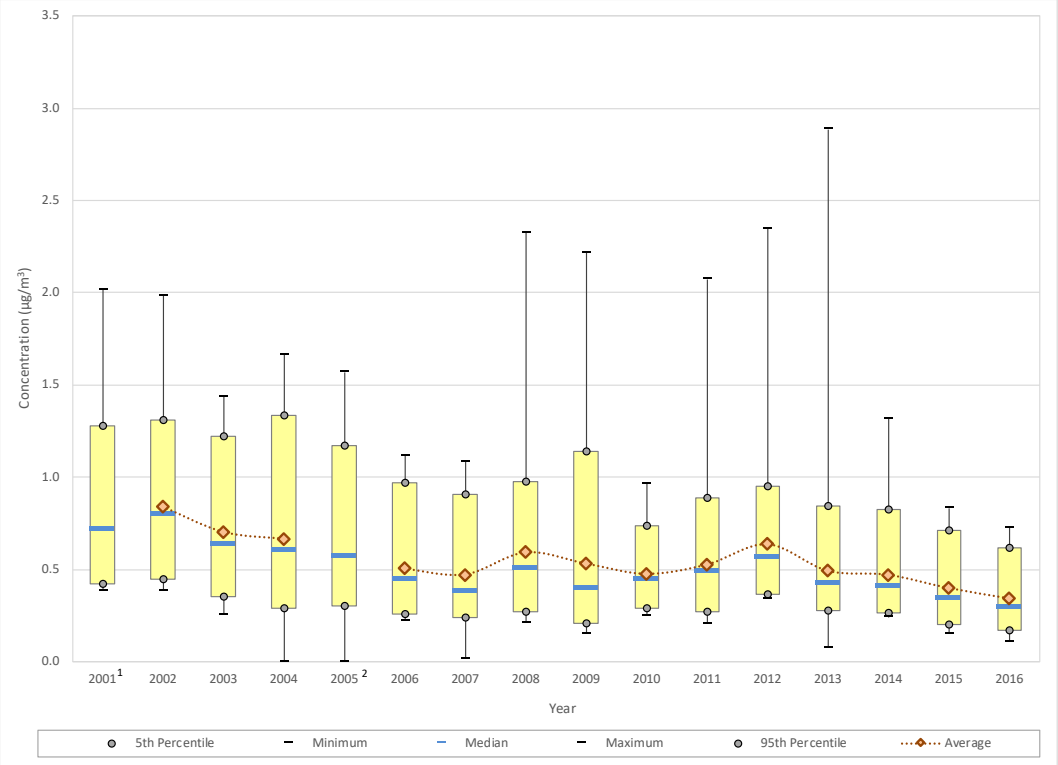
- An overall decreasing trend in the 1-year average concentrations is shown though 2006, with the exception of 2004, when the maximum concentrations were measured. Between 2006 and 2010 the 1-year average concentrations changed relatively little, varying by less than 0.25 µg/m^3 over these years.

- All of the statistical metrics exhibit an increase from 2010 to 2011. Although the maximum concentration increased again for 2012, all of the other statistical parameters decreased at least slightly. The 95th percentile decreased by nearly 1 µg/m^3 from 2011 to 2012, indicating that fewer concentrations at the upper end of the range were measured in 2012. The second highest concentration measured in 2012 is half the magnitude of the maximum concentration for 2012.

- A decreasing trend is shown after 2012 and continues through 2014. Additional decreases are shown for each of the statistical parameters for 2015, although a 1-year average concentration could not be calculated. The median acetaldehyde concentration for 2015 is less than 1 µg/m^3 for the first time and at a minimum for the period of sampling. However, only roughly half of the samples remained valid following the invalidation related to the contamination of the collection system.

- Although the range of acetaldehyde concentrations measured at CHNJ expanded slightly for 2016, the 1-year average concentration is at a minimum for 2016.

Figure 16-20. Yearly Statistical Metrics for Benzene Concentrations Measured at CHNJ



[1] A 1-year average is not presented because sampling under the NMP did not begin until May 2001.
[2] A 1-year average is not presented due to low completeness in 2005.

Observations from Figure 16-20 for benzene concentrations measured at CHNJ include the following:

- Similar to carbonyl compounds, sampling for VOCs under the NMP began at CHNJ in May 2001. Because a full year's worth of data is not available, a 1-year average concentration is not presented, although the range of measurements is provided. In addition, a 1-year average concentration for 2005 is not provided due to low completeness.

- The maximum benzene concentration measured at CHNJ was measured on September 13, 2013 (2.88 $\mu g/m^3$). In total, eight benzene concentrations greater than 2 $\mu g/m^3$ have been measured at CHNJ since the onset of sampling (one was measured in 2001, two in 2008, two in 2009, and one each in 2011, 2012, and 2013).

- The 1-year average and median concentrations exhibit a significant decreasing trend between 2002 and 2007, although a 1-year average concentration is not provided for 2005; 2007 is the first year that both the 1-year average and median concentrations are less than 0.5 $\mu g/m^3$.

- Even though an increase in the 1-year average concentration is shown from 2007 to 2008, this increase is being driven less by the two measurements greater than 2 $\mu g/m^3$ and more by the measurements in the mid- to upper-end of the concentration range. This is evident from the increase shown in the median concentration. The number of concentrations between 0.5 $\mu g/m^3$ and 1 $\mu g/m^3$ nearly doubled from 2007 to 2008 (from 15 to 28).

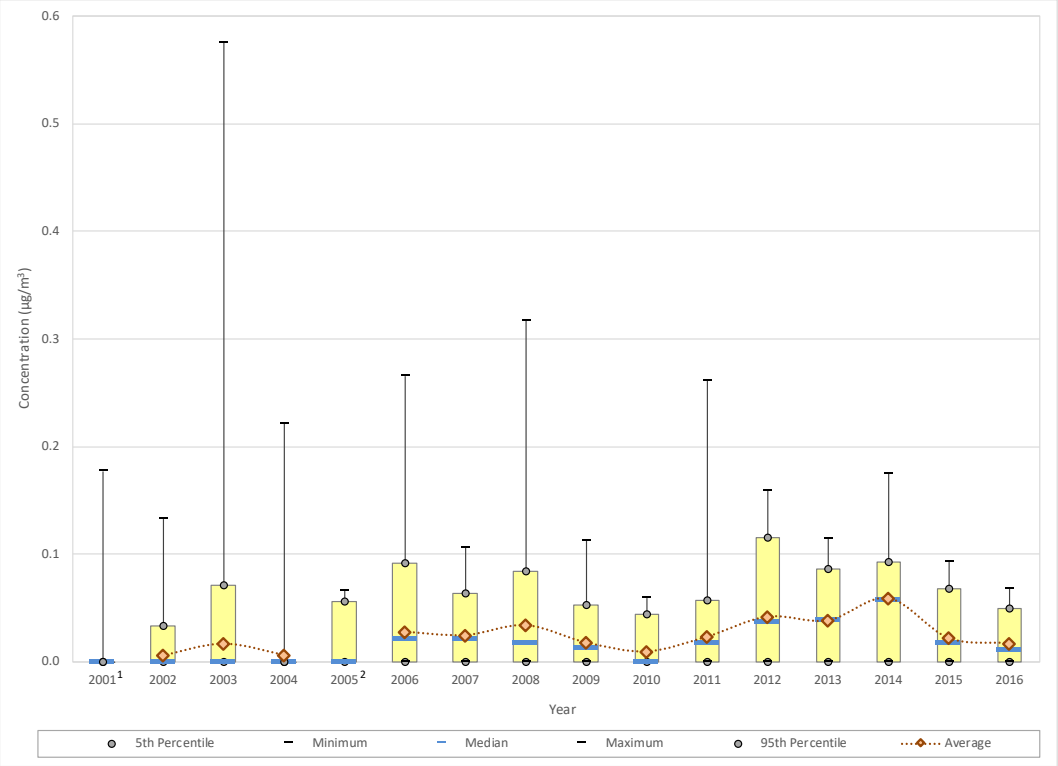
- The difference between the 5th and 95th percentiles, or the range within which the majority of concentrations fall, increased from 2008 to 2009, indicating that the majority of concentrations fell into a larger range and an increase in variability of the concentrations measured, despite the decreases shown in the 1-year average and median concentrations. Conversely, the difference between the 5th and 95th percentiles for 2010 is at its smallest since the onset of sampling.

- An increase in the 1-year average, median, 95th percentile, and maximum concentrations is shown from 2010 to 2011 and again for 2012. The 1-year average concentration increased each year during this period and in 2012 is at its highest since 2004.

- The 1-year average concentration has a significant decreasing trend after 2012. Although the range of concentrations measured is at its largest for 2013, both central tendency parameters exhibit decreases for 2013. The number of benzene concentrations greater than 0.5 $\mu g/m^3$ decreased from 43 measured in 2012 to 19 measured in 2013. Despite the differences in the minimum and maximum concentrations measured in 2013 and 2014, the 5th percentile, 95th percentile, 1-year average, and median concentrations exhibit little change from 2013 to 2014.

- Each of the statistical parameters exhibit decreases after 2014, with nearly all of them at a minimum for 2016.

Figure 16-21. Yearly Statistical Metrics for 1,3-Butadiene Concentrations Measured at CHNJ



[1] A 1-year average is not presented because sampling under the NMP did not begin until May 2001.
[2] A 1-year average is not presented due to low completeness in 2005.

Observations from Figure 16-21 for 1,3-butadiene concentrations measured at CHNJ include the following:

- The maximum 1,3-butadiene concentration was measured in 2003 (0.58 µg/m^3) and is the only concentration greater than 0.5 µg/m^3 measured at CHNJ. In total, five 1,3-butadiene concentrations measured at CHNJ are greater than 0.2 µg/m^3.

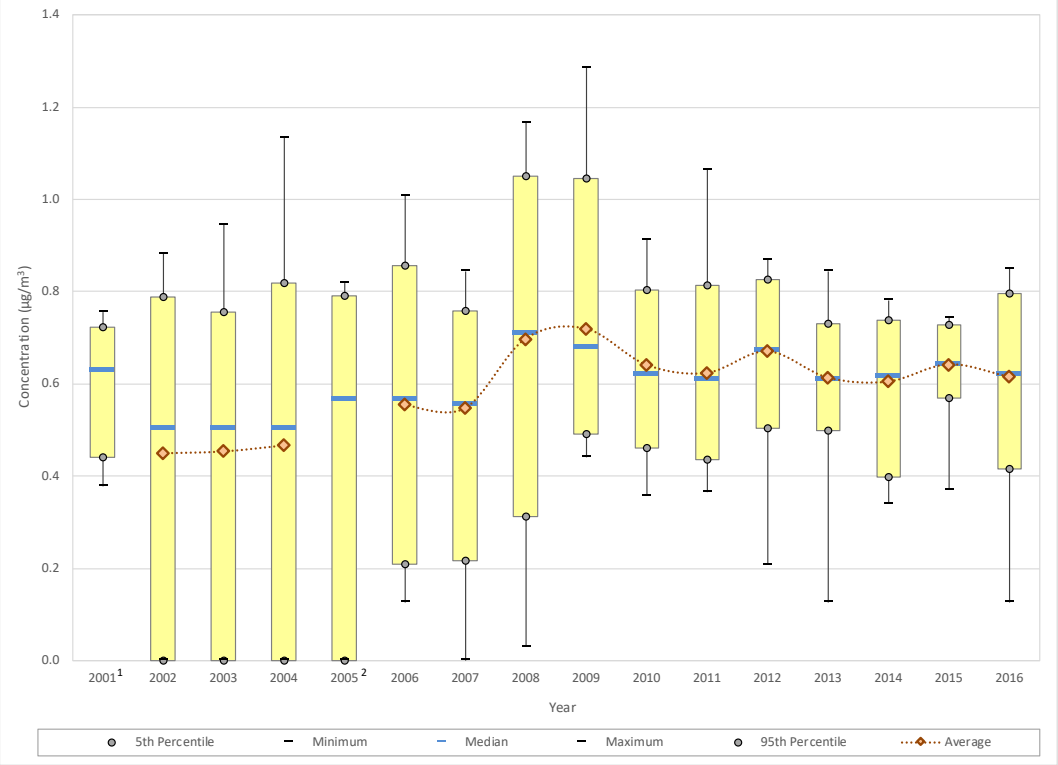
- For 2001 and 2004, the minimum, 5th percentile, median, and 95th percentile are zero. This is because the percentage of non-detects was greater than 95 percent for these years. More than 50 percent of the measurements were non-detects between 2001 and 2005 (as well as 2010), as indicated by the median concentration. The percentage of non-detects decreased steadily between 2004 (96 percent) and 2008 (17 percent). After 2008, the percentage of non-detects varies considerably, from fewer than 10 percent (2014) to greater than 70 percent (2010).

- The 1-year average and median concentrations have a decreasing trend from 2008 through 2010, which is followed by an increasing trend in the years immediately after. While these changes do correspond with the changes in non-detects discussed above, the measurement of concentrations on the higher end of the concentration range became more frequent over the years, particularly in 2014. The number of 1,3-butadiene concentrations greater than 0.05 µg/m^3 ranged from five to 10 between 2006 and 2008, decreased to four for 2009 and two for 2010, then increased each year

afterward, reaching a maximum of 40 in 2014, and accounting for more than half of the measurements for the first time. Thus, the increasing trend in the 1-year average and median concentrations shown between 2008 and 2014 are only partially explained by changes in the number of non-detects from year-to-year.

- Concentrations of 1,3-butadiene decreased significantly at CHNJ after 2014. The maximum concentration measured in 2015 is similar to the 95th percentile for 2014; likewise, the maximum concentration measured in 2016 is similar to the 95th percentile for 2015.

Figure 16-22. Yearly Statistical Metrics for Carbon Tetrachloride Concentrations Measured at CHNJ



[1] A 1-year average is not presented because sampling under the NMP did not begin until May 2001.
[2] A 1-year average is not presented due to low completeness in 2005.

Observations from Figure 16-22 for carbon tetrachloride concentrations measured at CHNJ include the following:

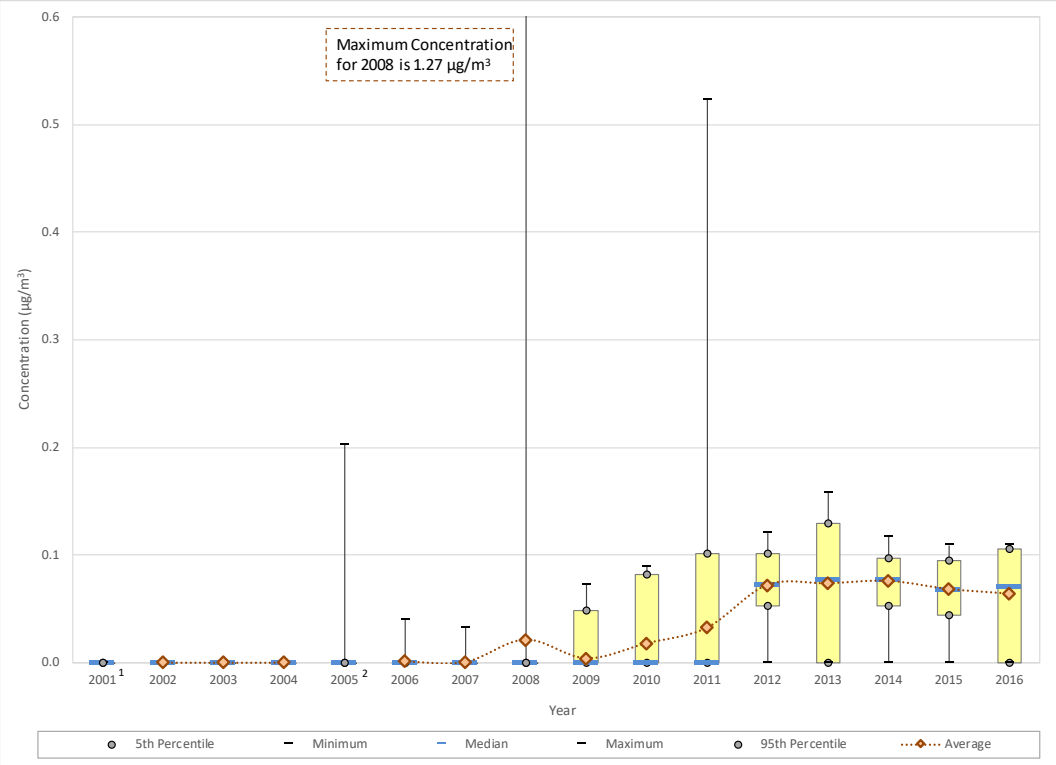
- The range of carbon tetrachloride concentrations measured appears to expand considerably from 2001 to 2002, with the measurement ranges changing only slightly through 2005. While a larger range of concentrations was measured during these years compared to 2001, the measurement of a few non-detects each year during this period contributes to degree of increase in the range shown. After 2005, only one non-detect was reported (2007).

- All of the statistical parameters exhibit an increase from 2007 to 2008. The 95th percentile for 2007 is just greater than the 1-year average and median concentrations

calculated for 2008. Thirteen concentrations measured in 2008 were greater than the maximum concentration measured in 2007, including seven greater than 1 µg/m^3. The number of measurements greater than 0.6 µg/m^3 nearly doubled from 2007 (21) to 2008 (39). A similar number of concentrations greater than 0.6 µg/m^3 was measured in 2009 and the minimum concentration increased by an order of magnitude from 2008. Yet the 1-year average increased only slightly and the median concentration decreased slightly.

- All of the statistical parameters exhibit decreases from 2009 to 2010, with little change shown for 2011, except for the maximum concentration. Between 2010 and 2016, the majority of carbon tetrachloride concentrations measured fell between 0.4 µg/m^3 and 0.8 µg/m^3. The 1-year average concentrations for the years 2010 through 2016 vary by less than 0.07 µg/m^3.

Figure 16-23. Yearly Statistical Metrics for 1,2-Dichloroethane Concentrations Measured at CHNJ



[1] A 1-year average is not presented because sampling under the NMP did not begin until May 2001.
[2] A 1-year average is not presented due to low completeness in 2005.

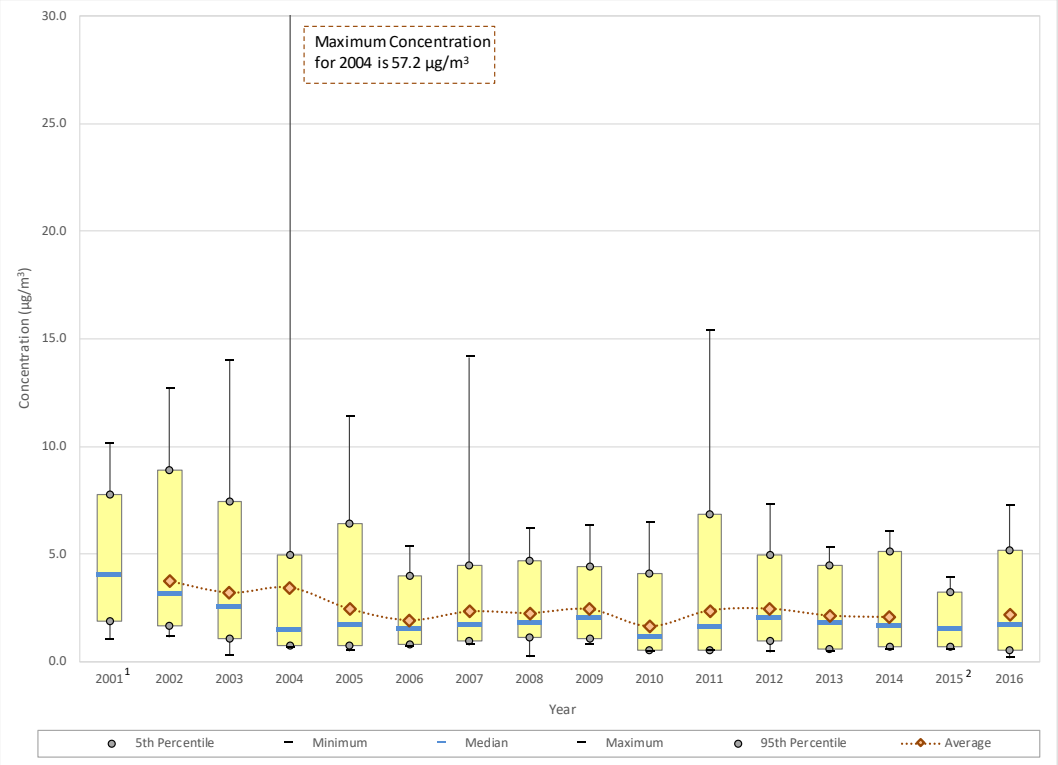
Observations from Figure 16-23 for 1,2-dichloroethane concentrations measured at CHNJ include the following:

- There were no measured detections of 1,2-dichloroethane between 2001 and 2004. There were one or two measured detections each year between 2005 and 2008. After 2008, the percentage of measured detections increased significantly, from 7 percent in 2009, to 25 percent for 2010, 30 percent in 2011, and 95 percent for 2012. This explains the significant increase in the 1-year average concentrations shown for the

later years of sampling. Measured detections account for at least 85 percent of concentrations measured during each of the last 5 years.

- The 1-year average and median concentrations vary little between 2012 and 2014, with each falling between 0.07 µg/m^3 and 0.08 µg/m^3. The 1-year average concentration decreases slightly for 2015 and again for 2016, although the changes are not statistically significant. The median concentration also decreases slightly for 2015 but increases slightly for 2016.

Figure 16-24. Yearly Statistical Metrics for Formaldehyde Concentrations Measured at CHNJ



[1] A 1-year average is not presented because sampling under the NMP did not begin until May 2001.
[2] A 1-year average is not presented due to a contamination issue with the collection system in 2015.

Observations from Figure 16-24 for formaldehyde concentrations measured at CHNJ include the following:

- The two highest formaldehyde concentrations were measured on the same days in 2004 as the two highest concentrations of acetaldehyde. The maximum concentration of formaldehyde (57.2 µg/m^3) is nearly twice the second highest concentration (30.4 µg/m^3) and an order of magnitude higher than the third highest concentration measured in 2004 (5.21 µg/m^3).

- With the exception of 2004, a decreasing trend in the 1-year average and median formaldehyde concentrations is shown though 2006. Slight increases in these parameters are shown for 2007, after which the 1-year average and median

concentrations changed little through 2009. Roughly 0.5 µg/m^3 separates the 1-year average concentrations calculated for the period between 2006 and 2009.

- The 1-year and median concentrations decreased significantly for 2010, the only year in which both statistical parameters are less than 2 µg/m^3. This is due primarily to the measurements at the lower end of the concentration range. The number of formaldehyde concentrations less than 1 µg/m^3 increased from two in 2009 to 21 in 2010.

- Similar to acetaldehyde, all of the statistical metrics calculated for formaldehyde exhibit an increase from 2010 to 2011, including the 95th percentile, which is greater than the maximum concentration measured in 2010. Four formaldehyde concentrations measured in 2011 are greater than the maximum concentration measured in 2010 and the number of measurements greater than 2 µg/m^3 nearly doubled, from 13 in 2010 to 25 in 2011.

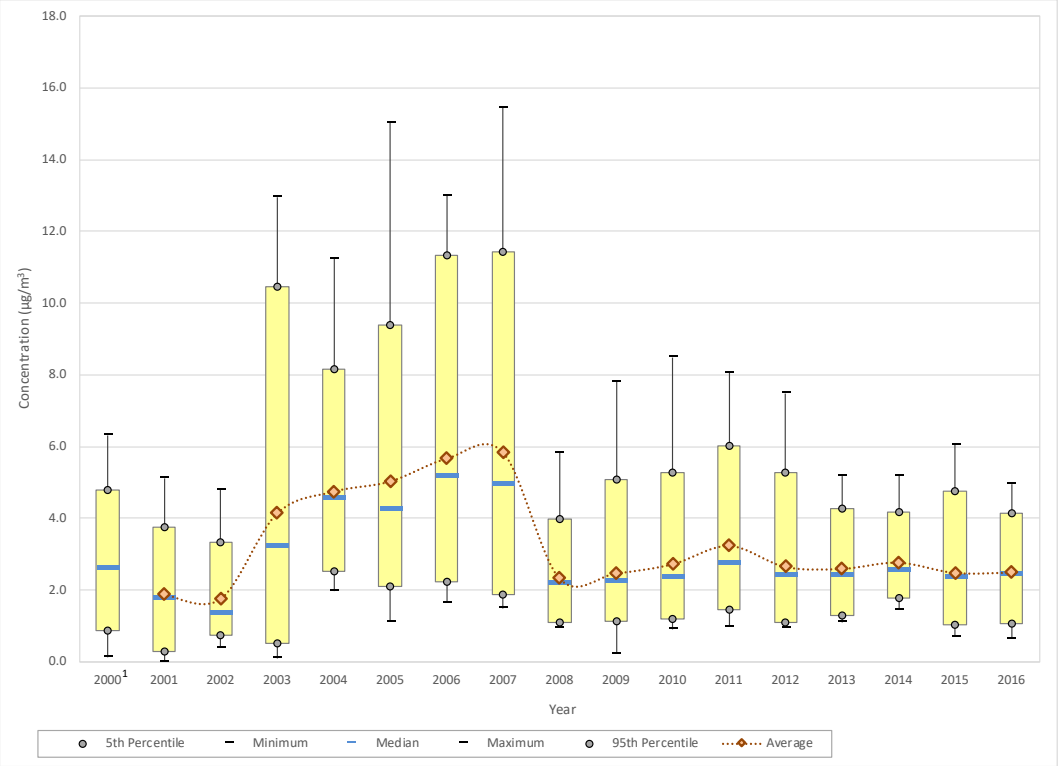
- Although the range of measurements decreased for 2012, little change is shown in the 1-year average concentration and the median continued to increase. This is primarily due to decreases in the number of concentrations at the lower end of the concentration range. The number of formaldehyde measurements less than 1 µg/m^3 decreased from 19 in 2011 to five in 2012.

- With the exception of the minimum concentration, all of the statistical parameters exhibit decreases for 2013, albeit slight ones. Relatively little change is shown in the range of concentrations measured in 2014 compared to 2013.

- While the smallest range of formaldehyde concentrations was measured at CHNJ in 2015, only roughly half of the samples remained valid following the invalidation related to a collection system contamination issue.

- The concentration profile for 2016 resembles the concentration profile for 2014. The 1-year average concentrations for 2013, 2014, and 2016 vary by less than 0.1 µg/m^3.

Figure 16-25. Yearly Statistical Metrics for Acetaldehyde Concentrations Measured at ELNJ



[1] A 1-year average is not presented due to low completeness in 2000.

Observations from Figure 16-25 for acetaldehyde concentrations measured at ELNJ include the following:

- ELNJ is the longest running NMP site. Carbonyl compound sampling under the NMP began at ELNJ in January 2000. However, sporadic sampling at the beginning of 2000 combined with a 1-in-12 day sampling schedule led to completeness less than 85 percent. Thus, a 1-year average concentration is not presented for 2000, although the range of measurements is provided.

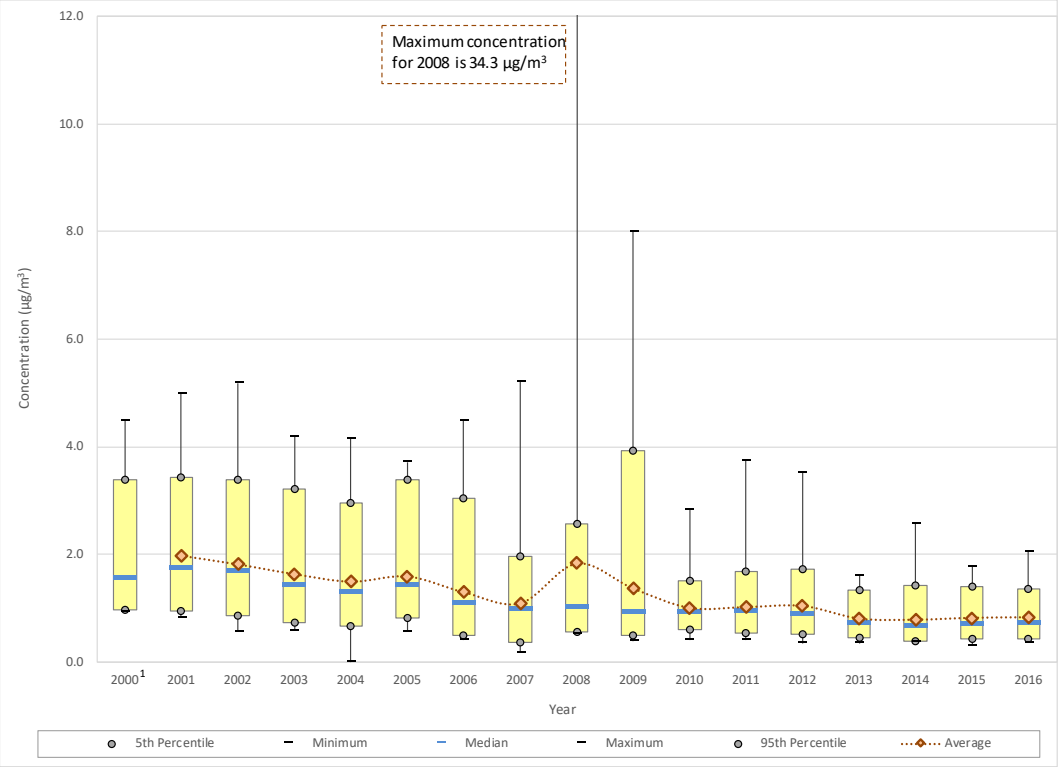
- The maximum acetaldehyde concentration was measured at ELNJ in 2007 (15.5 µg/m^3), although a concentration of similar magnitude was also measured in 2005. In total, 22 acetaldehyde concentrations greater than 10 µg/m^3 have been measured at ELNJ, all of which were measured between 2003 and 2007.

- The range of acetaldehyde concentrations measured between 2003 and 2007 is considerably higher than those collected during the first 3 years of sampling. The 1-year average concentration increased significantly from 2002 to 2003. This increasing trend continued through 2007, although the rate of change slowed over the years. A significant decrease in the measurements is shown from 2007 to 2008, where the maximum concentration measured in 2008 is less than the 1-year average calculated for 2007. The range of concentrations measured in 2008 is more similar to the range shown before 2003.

- Although an increasing trend is also shown between 2008 and 2011, the 1-year average concentrations are roughly half the magnitude of those shown before 2008.

- All of the statistical parameters exhibit decreases from 2011 to 2012, with additional decreases shown for some of the parameters for 2013. Despite variations in the range of acetaldehyde concentrations measured over the last five years of sampling at ELNJ, little change is shown in the central tendency parameters. Less than 0.30 µg/m^3 separates the 1-year average concentrations shown between 2012 and 2016; less than 0.25 µg/m^3 separates the median concentrations for these years.

Figure 16-26. Yearly Statistical Metrics for Benzene Concentrations Measured at ELNJ



[1] A 1-year average is not presented due to low completeness in 2000.

Observations from Figure 16-26 for benzene concentrations measured at ELNJ include the following:

- VOC sampling under the NMP also began at ELNJ in January 2000. However, a 1-year average concentration is not presented for 2000 due to low completeness, although the range of measurements is provided.

- The maximum benzene concentration (34.3 µg/m^3) was measured in 2008 and is more than four times higher than the next highest concentration (8.00 µg/m^3), which was measured in 2009. A total of five benzene concentrations greater than 5 µg/m^3 have been measured at ELNJ.

- A fairly steady decreasing trend in the 1-year average and median benzene concentrations is shown through 2007.

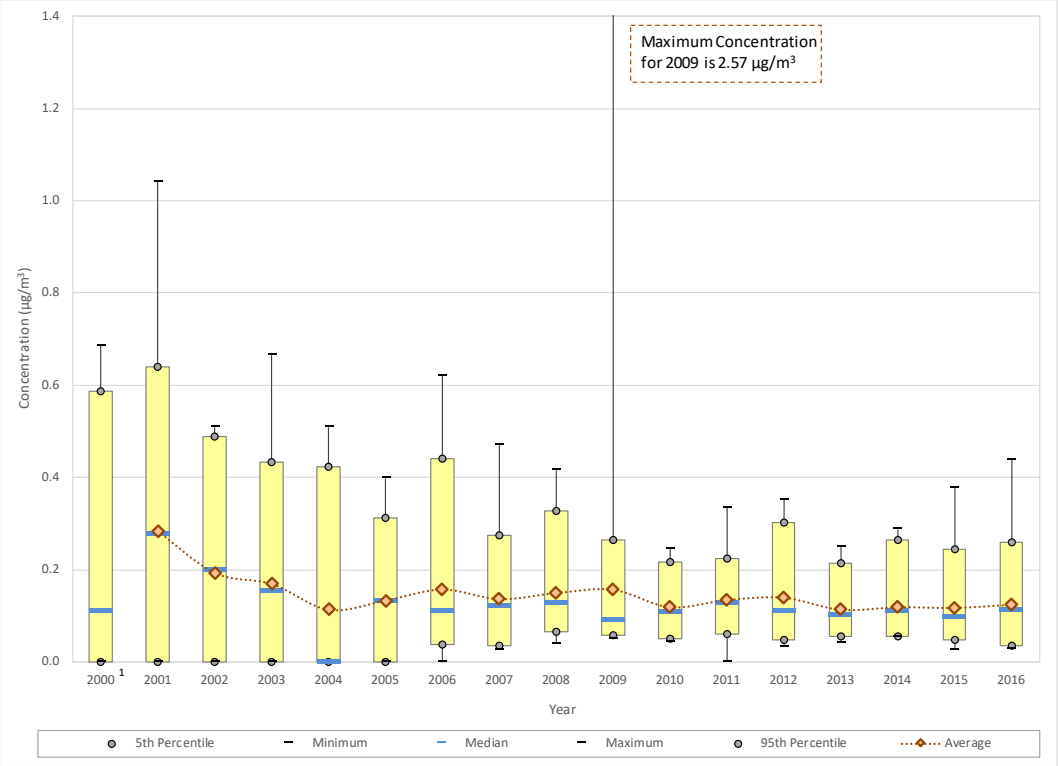
- All of the statistical parameters exhibit at least a slight increase for 2008. If the maximum concentration for 2008 was removed from the data set, the 1-year average concentration would exhibit only a slight increase for 2008. Thus, it is this single concentration that is primarily driving the change in the 1-year average concentration. The median concentration is influenced less by outliers, as this statistical parameter represents the midpoint of a data set. The median increased by less than 0.03 $\mu g/m^3$ between 2007 and 2008, further indicating that this outlier is the primary driver pulling the 1-year average concentration upward. However, the minimum concentration increased by a factor of three from 2007 to 2008, with eight concentrations measured in 2007 less than the minimum concentration measured in 2008, indicating that the outlier is not the only factor.

- Even though two of the three highest benzene concentrations were measured at ELNJ in 2009, the 1-year average concentration decreased from 2008 to 2009, likely a result of the magnitude of the outlier affecting the 2008 calculations. If the maximum concentration measured in 2008 was removed from the dataset, the 1-year average concentrations would exhibit a slight increasing trend between 2007 and 2009, although 2009 would then have the largest confidence interval among the years shown.

- Benzene concentrations measured in 2010, 2011, and 2012 were fairly consistent. The difference in the 1-year average concentrations for these years is less than 0.04 $\mu g/m^3$, with each hovering around 1 $\mu g/m^3$.

- Additional decreases are shown for 2013, as benzene concentrations greater than 2 $\mu g/m^3$ were not measured in 2013, and the 1-year average concentration is less than 1 $\mu g/m^3$ for the first time. Although a few higher concentrations were measured in the years that follow, the 1-year average benzene concentration changed little between 2013 and 2016.

Figure 16-27. Yearly Statistical Metrics for 1,3-Butadiene Concentrations Measured at ELNJ



[1] A 1-year average is not presented due to low completeness in 2000.

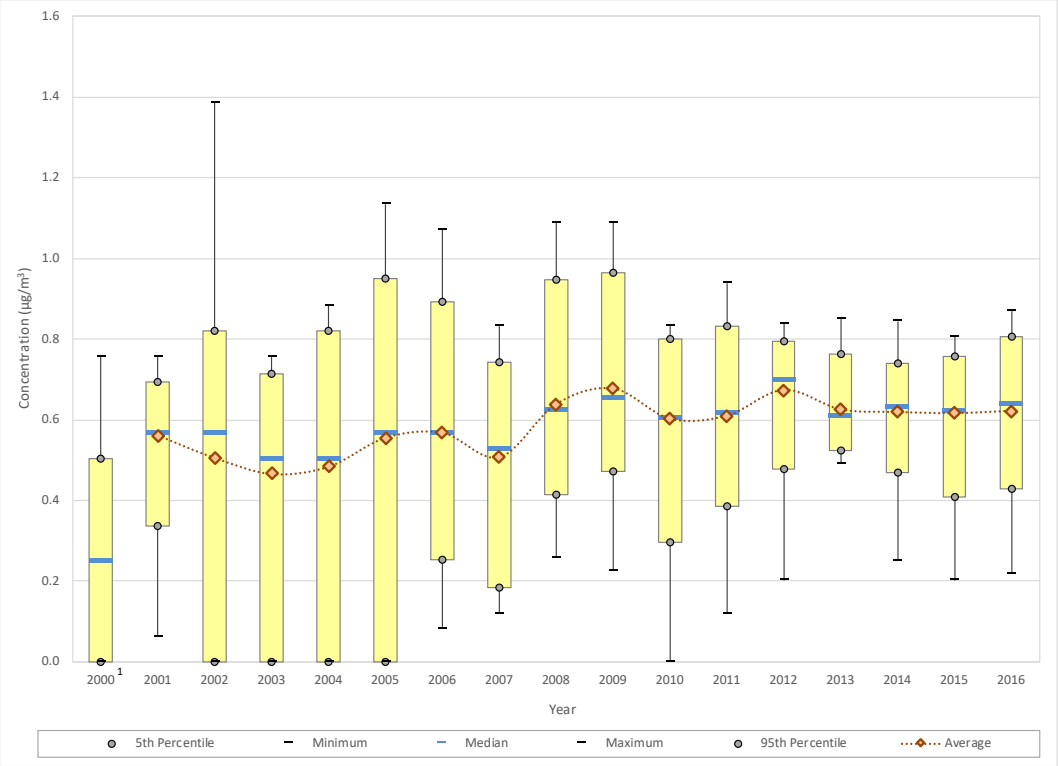
Observations from Figure 16-27 for 1,3-butadiene concentrations measured at ELNJ include the following:

- The maximum concentration of 1,3-butadiene (2.57 µg/m^3) was measured at ELNJ in 2009 and is nearly two and a half times the next highest concentration (1.04 µg/m^3, measured in 2001). These are the only concentrations of 1,3-butadiene measured at ELNJ that are greater than 1 µg/m^3. A total of 16 concentrations measured at ELNJ are greater than 0.5 µg/m^3, all of which were measured in 2009 or earlier.

- The minimum and 5th percentile are zero for the first 6 years of sampling, indicating that at least 5 percent of the measurements were non-detects. For 2004, the median concentration is also zero, indicating that at least half of the measurements were non-detects. Between 2000 and 2005, the percentage of non-detects ranged from 10 percent (2001) to 57 percent (2004). After 2005, only five non-detects of 1,3-butadiene have been measured at ELNJ (three in 2006 and two in 2011).

- A decreasing trend in the 1-year average concentration is shown through 2004, when the 1-year average is at a minimum. The 1-year average concentration is fairly static in the years that follow. Even with the higher concentration measured in 2009, the 1-year average concentration for 2009 is similar to the 1-year average concentration for 2008. Between 2004 and 2016, the 1-year average concentration has ranged from 0.11 µg/m^3 (2004 and 2013) to 0.16 µg/m^3 (2006 and 2009).

Figure 16-28. Yearly Statistical Metrics for Carbon Tetrachloride Concentrations Measured at ELNJ



[1] A 1-year average is not presented due to low completeness in 2000.

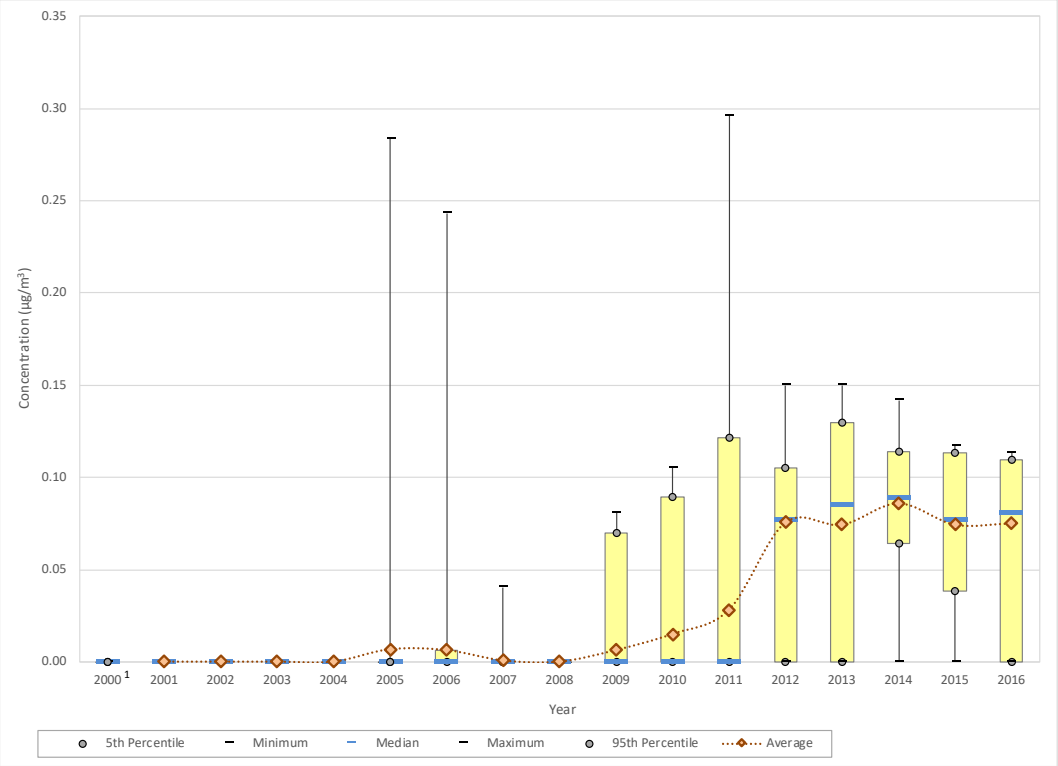
Observations from Figure 16-28 for carbon tetrachloride concentrations measured at ELNJ include the following:

- The minimum and 5th percentile are zero for five of the first 6 years of sampling, indicating that at least 5 percent of the measurements were non-detects (2001 being the exception). After 2005, only one non-detect has been reported (2010).

- The 1-year average carbon tetrachloride concentrations vary by approximately 0.1 µg/m^3 during the period from 2001 to 2007, even though the range of concentrations measured varies. All of the statistical parameters exhibit an increase in magnitude from 2007 to 2008, which is the first year that the 1-year average concentration is greater than 0.6 µg/m^3, with additional, albeit slight, increases for several of the parameters for 2009. All of the 1-year average concentrations between 2008 and 2014 are greater than 0.6 µg/m^3.

- The difference between the 5th percentile and 95th percentile, or the range within which the majority of measurements fall, has an overall decreasing trend after 2005 and is at a minimum for 2013 (less than 0.25 µg/m^3 separates the 5th percentile and 95th percentile for 2013). A slight widening of the range is shown over the last few years of sampling.

Figure 16-29. Yearly Statistical Metrics for 1,2-Dichloroethane Concentrations Measured at ELNJ



[1] A 1-year average is not presented due to low completeness in 2000.

Observations from Figure 16-29 for 1,2-dichloroethane concentrations measured at ELNJ include the following:

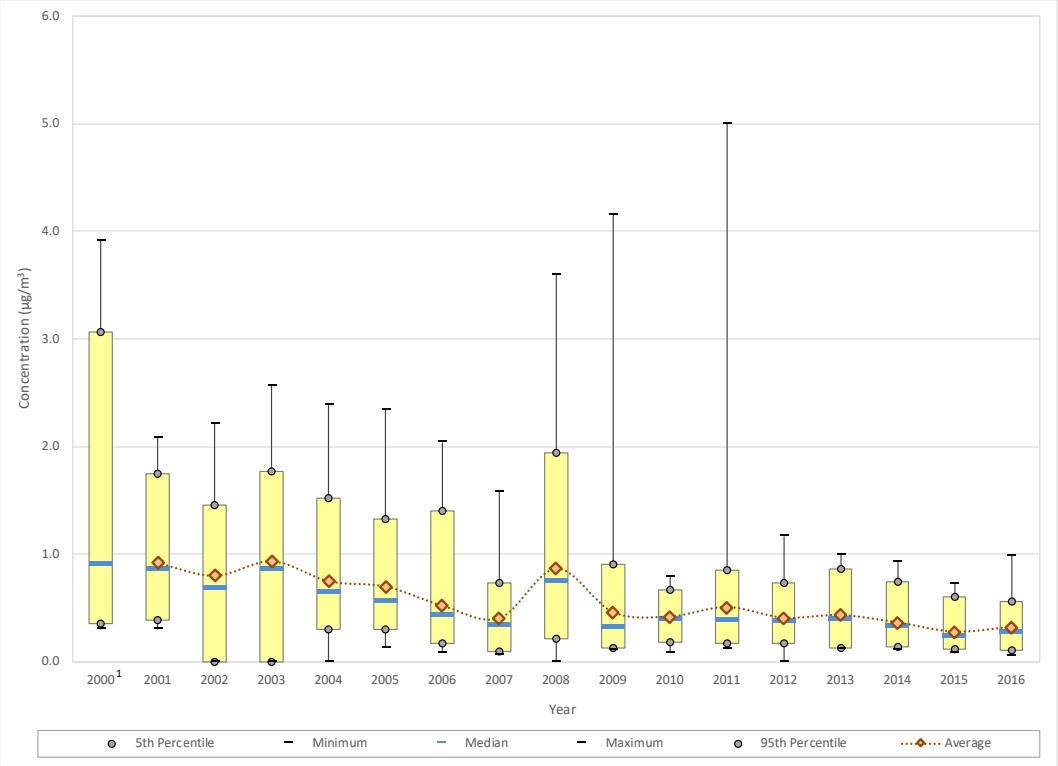
- There were no measured detections of 1,2-dichloroethane between 2000 and 2004. Between one and three measured detections were measured between 2005 and 2007, after which there were no measured detections in 2008. After 2008, the number of measured detections increased significantly, from five in 2009, to 11 for 2010, 16 in 2011, and 55 for 2012. With the exception of 2013, non-detects account for fewer than 10 percent of the measurements after 2011.

- 2012 is the first year that the median concentration is greater than zero, as only six non-detects were measured. The range of concentrations measured in 2012 is relatively small, ranging from 0.061 µg/m^3 to 0.150 µg/m^3. For 2013, the number of non-detects more than doubled (from six in 2012 to 14 in 2013) while the number of 1,2-dichloroethane concentrations greater than 0.1 µg/m^3 measured at ELNJ increased from eight in 2012 to 20 in 2013.

- 2014 and 2015 are the only years that the 5th percentile is greater than zero; a combined five non-detects were measured at ELNJ in 2014 and 2015. The 5th percentile returned to zero for 2016, when five non-detects were measured.

- Between 2012 and 2016, the 1-year average concentrations have ranged between 0.074 µg/m^3 (2013 and 2015) and 0.086 µg/m^3 (2014).

Figure 16-30. Yearly Statistical Metrics for Ethylbenzene Concentrations Measured at ELNJ



[1] A 1-year average is not presented due to low completeness in 2000.

Observations from Figure 16-30 for ethylbenzene concentrations measured at ELNJ include the following:

- ELNJ's concentration profiles for ethylbenzene resemble ELNJ's concentration profiles for benzene.

- There is a significant decreasing trend in the 1-year average and median concentrations of ethylbenzene between 2003 and 2007.

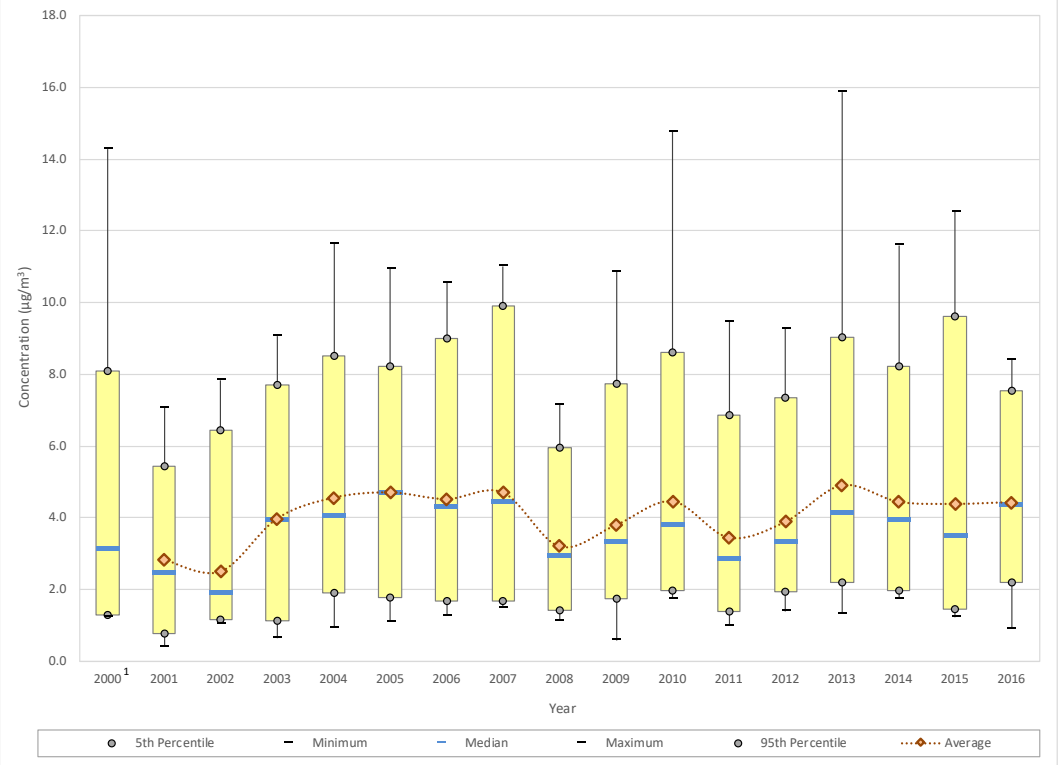
- A significant increase in the statistical parameters is shown for 2008. The maximum concentration measured in 2008 is more than twice the magnitude of the maximum concentration measured in 2007; further, 1-year average and median concentrations for 2008 are greater than the 95th percentile for 2007. The median concentration for 2008 is 0.76 µg/m^3, indicating that half of the concentrations measured at ELNJ in 2008 are greater than this concentration. By comparison, only three concentrations measured in 2007 are greater than the median for 2008.

- The concentrations profile for 2009 more closely resembles the concentration profile for 2007, with the exception of the maximum concentration measured.

- The despite the differences in the range of ethylbenzene concentrations measured each year between 2009 and 2012, less than 0.1 µg/m^3 separates the 1-year average concentrations.

- After 2012, the range of concentrations measured compresses slightly each year through 2015, when less than 0.65 µg/m^3 separates the minimum and maximum concentrations measured. Both central tendency parameters are also at a minimum for 2015. Relatively little change is shown for 2016,

Figure 16-31. Yearly Statistical Metrics for Formaldehyde Concentrations Measured at ELNJ



[1] A 1-year average is not presented due to low completeness in 2000.

Observations from Figure 16-31 for formaldehyde concentrations measured at ELNJ include the following:

- The maximum formaldehyde concentration was measured at ELNJ in 2013 (15.9 µg/m^3). A total of 18 concentrations greater than 10 µg/m^3 have been measured at ELNJ, with the most measured in 2007 and 2015 (three each year).

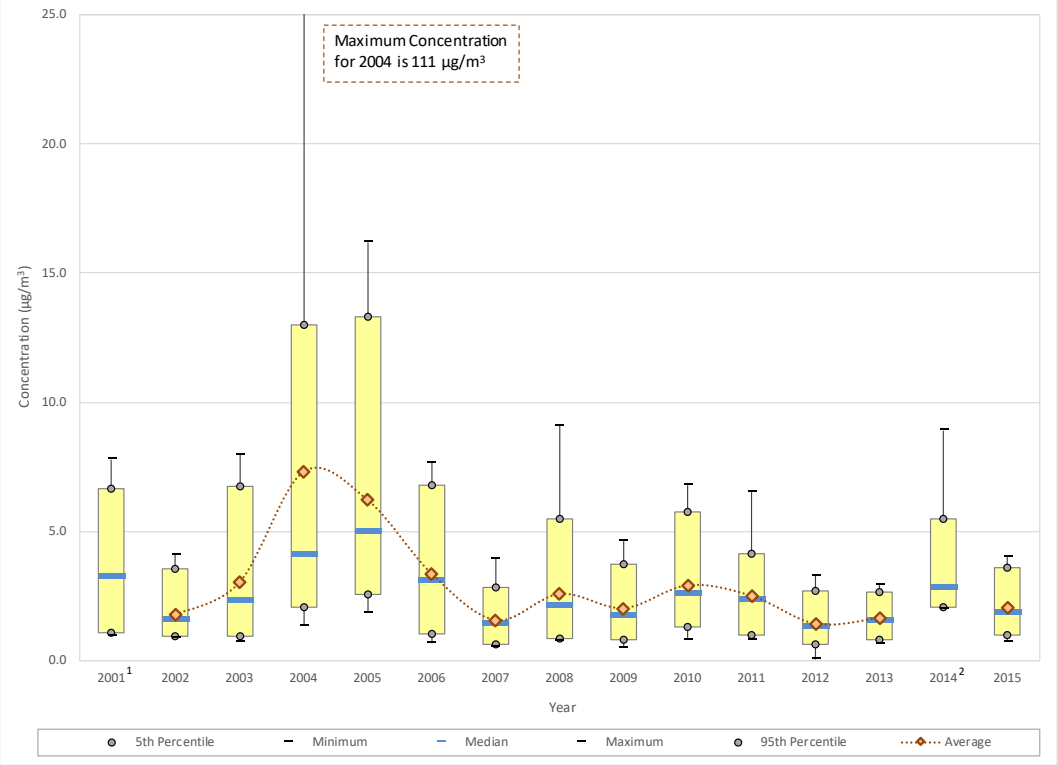
- After decreasing by more than 1 µg/m^3 from 2000 to 2002, the median concentration increased by more than 2 µg/m^3 for 2003. The 1-year average concentration also exhibits a significant increase for 2003, with additional increases in both parameters shown for 2004 and 2005. The number of formaldehyde concentrations greater than 4 µg/m^3 nearly tripled from 2002 to 2003 (from 9 to 25), and continued increasing through 2005, with concentrations greater than 4 µg/m^3 accounting for at least half of the concentrations measured each year through 2007.

- Similar to acetaldehyde, the 1-year average and median concentrations of formaldehyde decreased significantly between 2007 and 2008, as the magnitude of concentrations measured decreased considerably. Afterward, an increasing trend is

shown through 2010, followed by a decrease for 2011, then another round of increasing. The 1-year average concentration of formaldehyde for 2013 (4.90 µg/m^3) is the highest 1-year average calculated since the onset of sampling.

- A slight decrease is shown in all of the statistical parameters for 2014 except the minimum concentration (which is at a maximum for 2014). The 1-year average concentration changed little over the last three years of sampling, despite differences in the magnitude of concentrations measured, hovering around 4.40 µg/m^3 for each year.

Figure 16-32. Yearly Statistical Metrics for Acetaldehyde Concentrations Measured at NBNJ



[1] A 1-year average is not presented because sampling under the NMP did not begin until May 2001.
[2]A 1-year average is not presented due to a contamination issue with the collection system in 2014.

Observations from Figure 16-32 for acetaldehyde concentrations measured at NBNJ include the following:

- Sampling for carbonyl compounds under the NMP began at NBNJ in May 2001. Because a full year's worth of data is not available for 2001, a 1-year average concentration is not presented, although the range of measurements is provided. In addition, a contamination issue with the collection system resulted in the invalidation of carbonyl compound data from May 2014 through the end of the year; thus, a 1-year average concentration is not provided for 2014, although the range of concentrations is provided.

- The maximum acetaldehyde concentration was measured in 2004 (111 µg/m^3). This concentration is nearly seven times higher than the next highest concentration (16.2 µg/m^3, measured in 2005).

- All 17 acetaldehyde concentrations greater than 10 µg/m were measured in either 2004 or 2005. This, along with the outlier concentration measured in 2004, explains the significant increase in the statistical metrics shown from 2003 to 2004. Even without an outlier for 2005, most of the statistical metrics for 2005 exhibit slight increases from 2004 levels. The 1-year average concentration, however, does not. If the outlier was removed from the data set for 2004, the 1-year average concentration for 2004 would be less than the 1-year average concentration for 2005.

- Each of the statistical parameters decreases significantly between 2005 and 2007, with the 1-year average concentration decreasing from 6.21 µg/m^3 to 1.56 µg/m^3. This is followed by a significant increase in the concentrations measured for 2008, with the range of concentrations measured doubling.

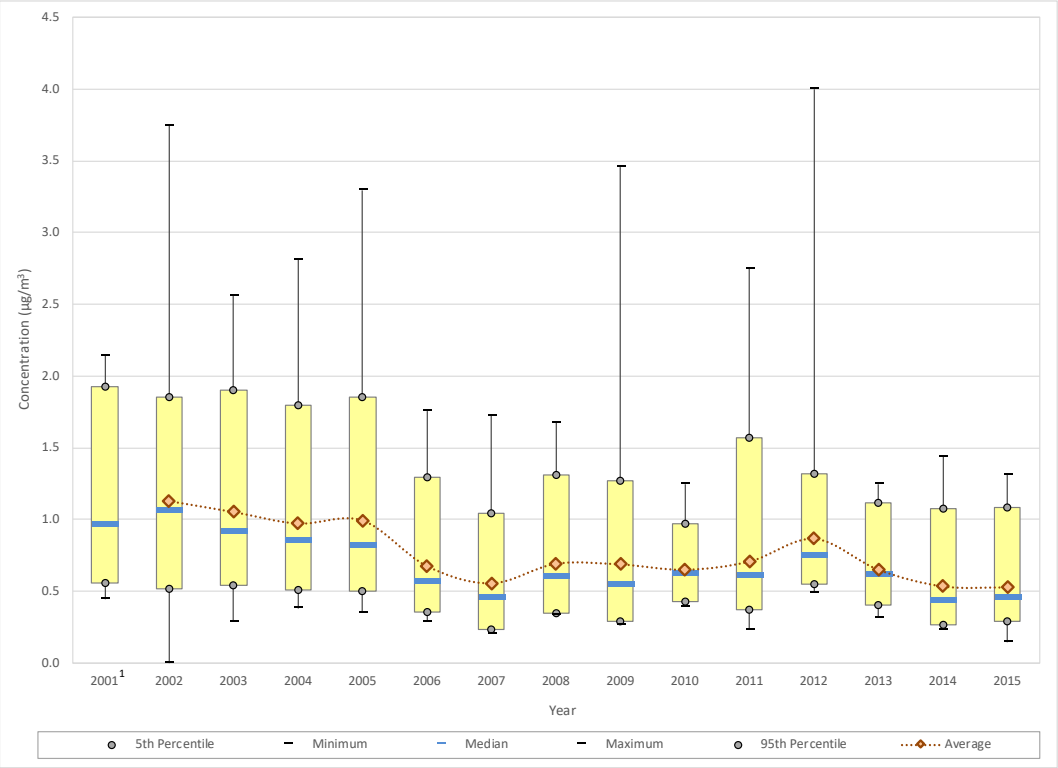
- Between 2008 and 2011, the 1-year average concentrations have an undulating pattern, fluctuating between 2 µg/m^3 and 3 µg/m^3.

- The acetaldehyde concentrations measured at NBNJ decreased significantly for 2012, with both the 1-year average and median concentrations at a minimum (1.41 µg/m^3 and 1.36 µg/m^3, respectively). The smallest range of acetaldehyde concentrations was measured at NBNJ in 2013, although slight increases are shown for the 1-year average and median concentrations.

- For 2014, a contamination issue with the collection system resulted in the invalidation of carbonyl compound data from May 2014 through the end of the year. Thus, the concentration profile for 2014 includes samples collected during the first four months of the year. The minimum concentration measured in 2014 is greater than the 1-year average concentration for 2013 and the median concentration for 2014 is similar to the maximum concentration measured in 2013.

- Each of the available statistical parameters exhibit a decrease from 2014 to 2015, after which sampling at NBNJ was discontinued and moved to NRNJ.

Figure 16-33. Yearly Statistical Metrics for Benzene Concentrations Measured at NBNJ



[1] A 1-year average is not presented because sampling under the NMP did not begin until May 2001.

Observations from Figure 16-33 for benzene concentrations measured at NBNJ include the following:

- Sampling for VOCs under the NMP also began at NBNJ in May 2001. Because a full year's worth of data is not available for 2001, a 1-year average concentration is not presented, although the range of measurements is provided.

- The maximum benzene concentration was measured in 2012 (4.00 µg/m^3); three additional concentrations of benzene greater than 3 µg/m^3 have been measured at NBNJ.

- The 1-year average concentration decreases slightly between 2002 and 2004, exhibits little change for 2005 before decreasing significantly for 2006 and 2007. The median concentration for 2007 is less than 0.5 µg/m^3 for the first time since the onset of sampling.

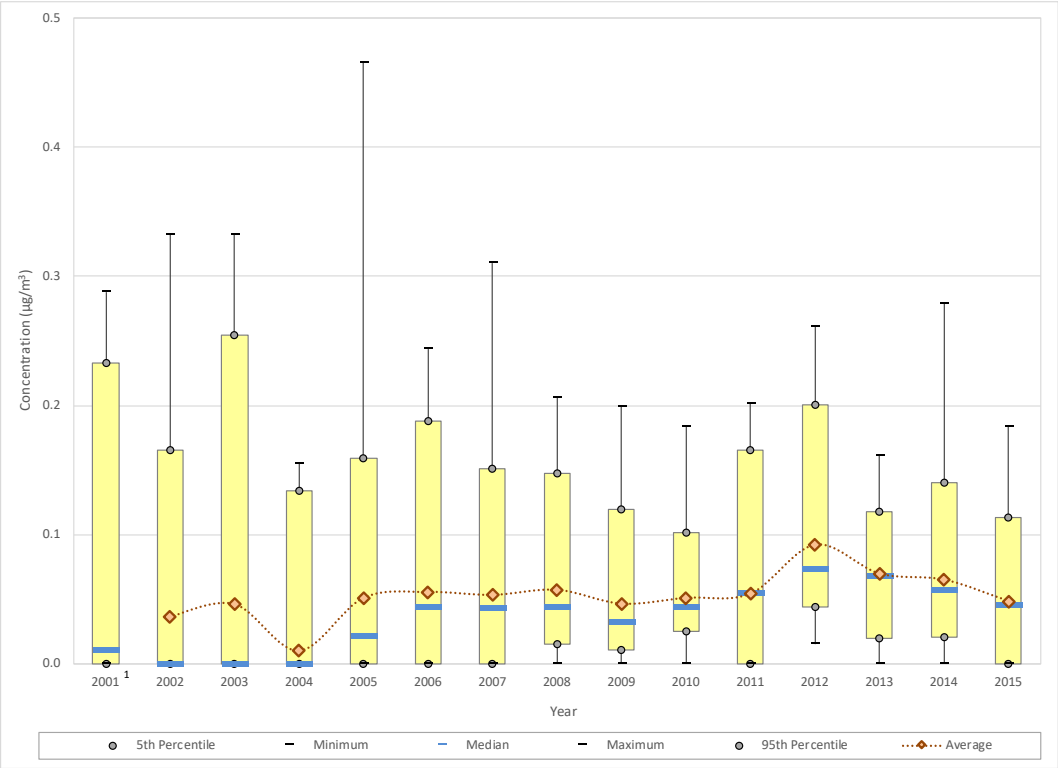
- With the exception of the maximum concentration, all of the statistical parameters exhibit an increase for 2008, representing a return to 2006 levels for most of the parameters.

- Between 2008 and 2011, the 1-year average concentration changes little, ranging from 0.65 µg/m^3 (2010) to 0.71 µg/m^3 (2011), even though there is considerable fluctuation in the range of benzene concentrations measured.

- The 1-year average benzene concentration exhibits an increase from 2011 to 2012, as did many of the statistical parameters, even though the majority of the measurements fell into a smaller range for 2012 than 2011, as indicated by the 5th and 95th percentiles. The minimum and 5th percentile increased considerably for 2012; 17 benzene concentrations measured in 2011 are less than the minimum concentration measured in 2012 (0.49 µg/m^3). In addition, the number of measurements at the upper-end of the concentration range increased substantially for 2012. In addition to a higher maximum concentration, the number of benzene measurements greater than 0.75 µg/m^3 increased from 11 in 2011 to 31 in 2012, accounting for more than half of the concentrations measured in 2012.

- A significant decrease in the 1-year average concentrations is shown after 2012. The 1-year average concentration is at a minimum for 2015 (though there is little difference between these parameters for 2014 and 2015).

Figure 16-34. Yearly Statistical Metrics for 1,3-Butadiene Concentrations Measured at NBNJ



[1] A 1-year average is not presented because sampling under the NMP did not begin until May 2001.

Observations from Figure 16-34 for 1,3-butadiene concentrations measured at NBNJ include the following:

- The maximum 1,3-butadiene concentration was measured at NBNJ in 2005 (0.47 µg/m^3) and is the only measurement greater than 0.35 µg/m^3 measured at NBNJ.

- The minimum, 5th percentile, and median concentrations are zero for 2002 through 2004. This indicates that at least half of the measurements were non-detects for these years, and for 2004, non-detects accounted for all but four of the measurements. The median concentration increased from 2004 to 2005, with the number of non-detects decreasing by half. The minimum and 5th percentile are still zero for 2005 through 2007. Further decreases in the number of non-detects are indicated by the 5th percentile increasing for 2008 through 2010, when the number of non-detects ranged from one (2008) to three (2009). The number of non-detects increased considerably for 2011 (17), an increase that is evident from the return of the 5th percentile to zero. There were no non-detects measured in 2012, as indicating by the minimum concentration, which is greater than zero for the first time. Between three and five non-detects were measured each year between 2013 and 2015.

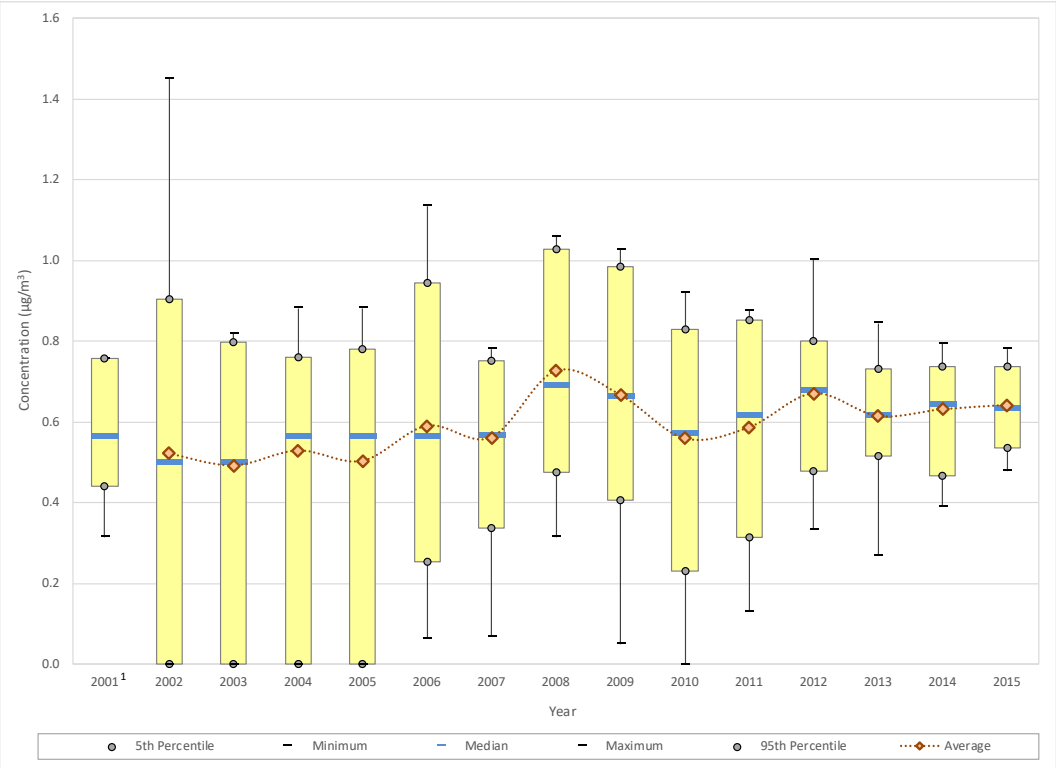
- The 1-year average concentration of 1,3-butadiene decreased significantly from 2003 to 2004. This is primarily a result in the number of non-detects, which increased from 35 in 2003 to 56 in 2004. Thus, many zeros were substituted into this average. The increase in the 1-year average concentration shown from 2004 to 2005 results from a combination of fewer non-detects and a larger range of concentrations measured. The number of non-detects decreased to 27 for 2005, accounting for fewer than half of the measurements for the first time.

- The 1-year average concentration exhibits little change between 2005 and 2011, ranging from 0.047 $\mu g/m^3$ (2009) to 0.057 $\mu g/m^3$ (2008), even as the range within which the majority of the concentrations are measured tightened each year through 2010.

- The 1-year average concentration increases significantly from 2011 to 2012. Increases are also exhibited by each of the other statistical parameters. This is largely due to the decrease in non-detects (and thus, the number of zeroes substituted for non-detects in the calculations) from 17 non-detects in 2011 to zero for 2012. The number of concentrations at the upper end of the concentration range increased as well; the number of measurements greater than 0.1 $\mu g/m^3$ more than doubled, increasing from eight in 2011 to 18 in 2012.

- A decreasing trend in 1,3-butadiene concentrations is shown after 2012, and by 2015, have returned to levels measured prior to 2012.

Figure 16-35. Yearly Statistical Metrics for Carbon Tetrachloride Concentrations Measured at NBNJ



[1] A 1-year average is not presented because sampling under the NMP did not begin until May 2001.

Observations from Figure 16-35 for carbon tetrachloride concentrations measured at NBNJ include the following:

- The range of carbon tetrachloride concentrations measured in 2001 was considerably smaller than those collected in the years immediately following. The considerable decrease in the minimum concentration shown for 2002 to 2005 is due to non-detects, which account for at least 5 percent of the concentrations measured for each year during this time frame.

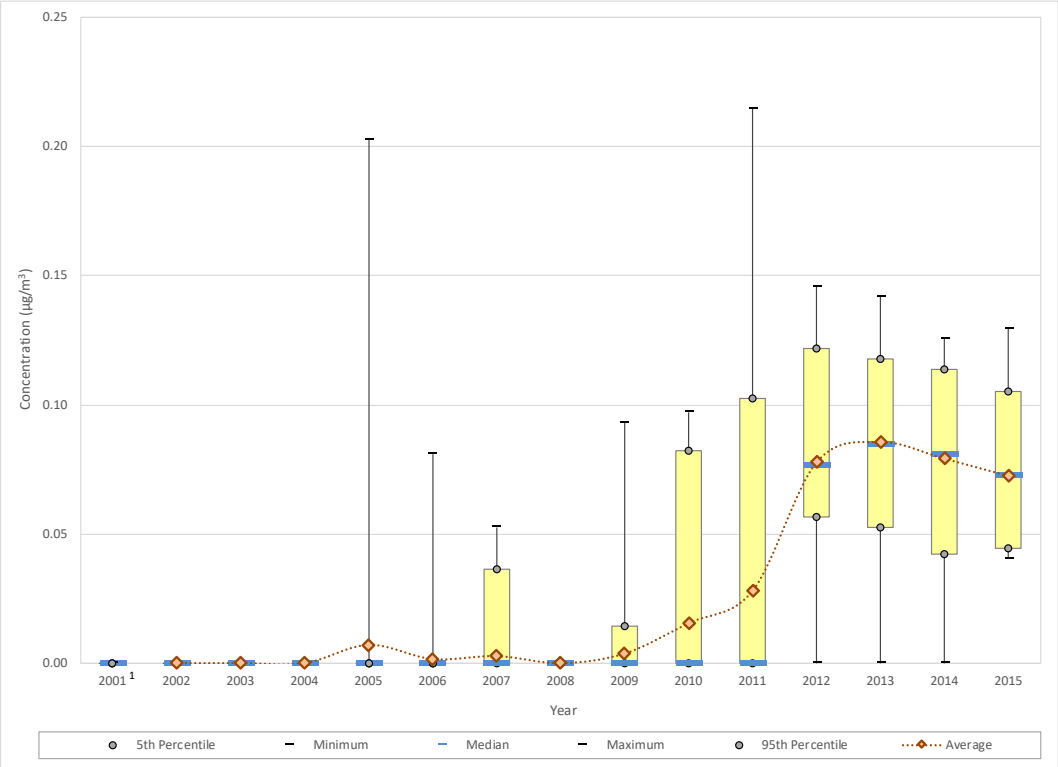
- The 1-year average concentration changed little between 2002 and 2005, ranging from 0.49 µg/m^3 to 0.53 µg/m^3. An increase in the 1-year average concentration is shown from 2005 to 2006, although the change is not statistically significant. This is a result of higher concentrations at the upper end of the concentration range combined with the loss of non-detects. A slight decrease in the 1-year average is shown from 2006 to 2007, as the majority of measurements fell into a tighter concentration range. Between 2004 and 2007, the median concentration varied by only 0.003 µg/m^3, despite variations in the range of concentrations measured.

- All of the statistical parameters exhibit increases for 2008. The minimum concentration measured increased considerably from 2007 to 2008. In addition, 20 concentrations measured in 2008 were greater than the maximum concentration measured in 2007.

- Each of the statistical parameters exhibits a decrease after 2008 that continues through 2010. This is followed by an increase in most of the statistical parameters through 2012.

- The range of carbon tetrachloride concentrations measured at NBNJ decreased over the last several years of sampling, which is particularly evident for 2014 and 2015, when the smallest range of concentrations was measured.

Figure 16-36. Yearly Statistical Metrics for 1,2-Dichloroethane Concentrations Measured at NBNJ



[1] A 1-year average is not presented because sampling under the NMP did not begin until May 2001.

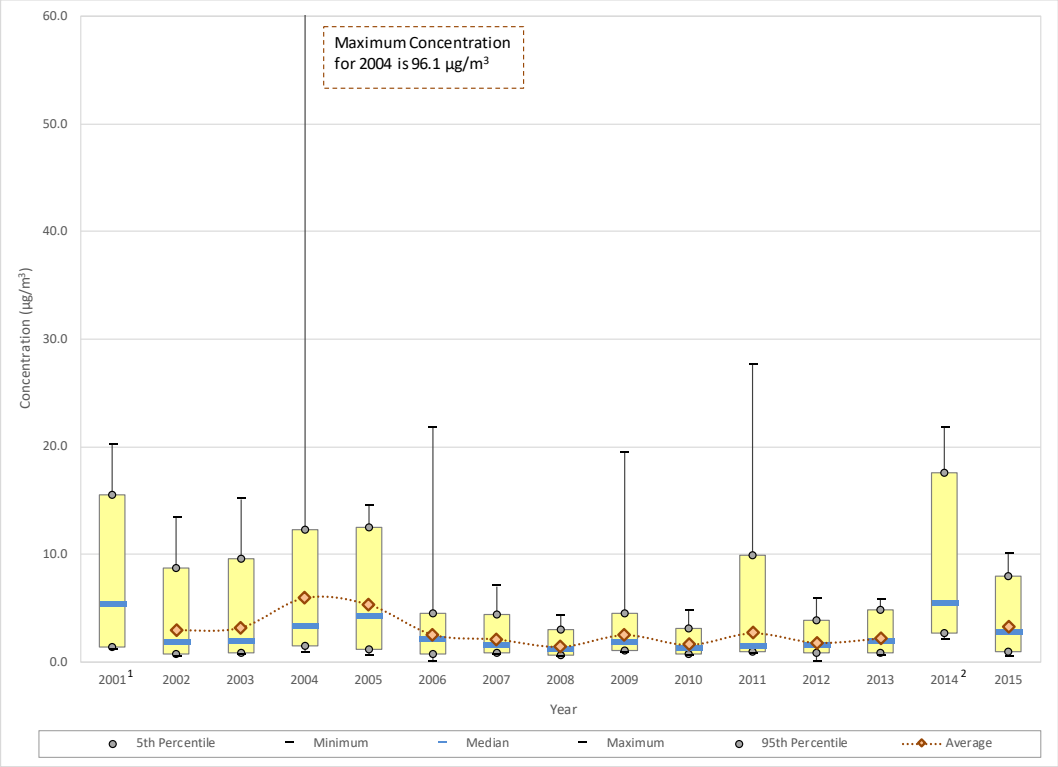
Observations from Figure 16-36 for 1,2-dichloroethane concentrations measured at NBNJ include the following:

- There were no measured detections of 1,2-dichloroethane between 2001 and 2004. Between 2005 and 2007, fewer than five measured detections were measured year year, after which there were no measured detections in 2008. After 2008, the number of measured detections increased significantly, from a total of three in 2009, to 11 for 2010, 18 in 2011, and 58 for 2012. The detection rate was at or above 95 percent for each of the last four years of sampling, including 2015, when there are no non-detects. This increase in the number of measured detections is very similar to what was exhibited by the measurements at CHNJ and ELNJ. This also explains the significant increase in the 1-year average concentrations shown, particularly for the later years of sampling.

- Excluding non-detects, the range of 1,2-dichloroethane concentrations measured in 2012 is relatively small, ranging from 0.053 µg/m^3 to 0.146 µg/m^3. Although a relatively similar range was measured in 2013, the central tendency parameters both exhibit increases. The number of 1,2-dichloroethane concentrations greater than 0.1 µg/m^3 increased by a factor of three from 2012 (6) to 2013 (18).

- A slight decreasing trend in 1,2-dichloroethane concentrations is shown through 2015.

Figure 16-37. Yearly Statistical Metrics for Formaldehyde Concentrations Measured at NBNJ



[1] A 1-year average is not presented because sampling under the NMP did not begin until May 2001.
[2]A 1-year average is not presented due to a contamination issue with the collection system in 2014.

Observations from Figure 16-37 for formaldehyde concentrations measured at NBNJ include the following:

- The maximum formaldehyde concentration (96.1 µg/m^3) was measured at NBNJ on the same day in 2004 that the highest acetaldehyde concentration was measured (August 31, 2004). This concentration of formaldehyde is more than three times greater than the next highest concentration (27.7 µg/m^3, measured in 2011). A total of 37 formaldehyde concentrations greater than 10 µg/m^3 have been measured at NBNJ, with at least one measured during 10 of the 15 years of sampling.

- After little change between 2002 and 2003, each of the statistical metrics exhibit increases from 2003 to 2004. This is due in part to the outlying concentration measured in 2004; however, concentrations were higher overall in 2004 compared to

2003. If the maximum concentration was excluded from the calculations for 2004, the 1-year average concentration for 2004 would still exhibit more than a 1 $\mu g/m^3$ increase. This is also true for the median concentration. The number of formaldehyde concentrations greater than 3 $\mu g/m^3$ more than doubled from 2003 to 2004, from 16 to 34. Excluding the outlier, the range of concentrations measured in 2004 is similar to the range measured in 2005, yet the median concentration exhibited another 1 $\mu g/m^3$ increase. The number of formaldehyde concentrations greater than 3 $\mu g/m^3$ increased further for 2015, accounting for more than 75 percent of the measurements in 2005.

- After 2005, concentrations of formaldehyde measured at NBNJ decreased significantly, with the 1-year average and median concentrations decreasing each year and reaching a minimum for 2008. This year also has the smallest range of formaldehyde concentrations measured, although a similar range was also measured in 2010.

- Between 2008 and 2012, a year with more variability in the measurements alternates with a year with less variability.

- Though the range of concentrations measured in 2013 is fairly similar to the range measured in 2012, both central tendency parameters are greater than 2 $\mu g/m^3$ for the first time since 2006. The number of formaldehyde concentrations greater than 3 $\mu g/m^3$, which had not changed much between 2010 and 2012, doubled from 2012 (7) to 2013 (14).

- A 1-year average concentration is not provided for 2014, as a collection system contamination issue resulted in the invalidation of carbonyl compound data from May 2014 through the end of the year. The statistical metrics shown for formaldehyde for 2014 resemble those shown for acetaldehyde in Figure 16-32. Nine formaldehyde concentrations measured in 2014 are greater than the maximum concentration measured in 2013 and the median concentration for 2014 is greater than the 95th percentile shown for 2013.

- All of the statistical parameters exhibit decreases from 2014 to 2015. However, if 2014 data is excluded, concentrations of formaldehyde exhibit an increasing trend, with the 1-year average concentration nearly doubling between 2012 (1.83 $\mu g/m^3$) and 2015 (3.29 $\mu g/m^3$).

16.4 Additional Risk-Based Screening Evaluations

The following risk-based screening evaluations were conducted to characterize risk related to the air toxics measured at each New Jersey monitoring site. Refer to Sections 3.2, 3.4.2.3, and 3.4.2.4 for definitions and explanations regarding the various toxicity factors, time frames, and calculations associated with these risk-based screenings.

16.4.1 Cancer Risk and Noncancer Hazard Approximations

For the pollutants of interest for the New Jersey sites, risk was examined by calculating cancer risk and noncancer hazard approximations for each year annual average concentrations could be calculated. These approximations can be used as risk estimates for cancer and noncancer effects attributable to the pollutants of interest. Although the use of these approximations is limited, they may help identify where policy-makers want to shift their air monitoring priorities. Refer to Section 3.4.2.3 for an explanation of how cancer risk and noncancer hazard approximations are calculated and what limitations are associated with them. Annual averages, cancer UREs and/or noncancer RfCs, and cancer risk and noncancer hazard approximations are presented in Table 16-4, where applicable. Cancer risk approximations are presented as probabilities while the noncancer hazard approximations are ratios and thus, unitless values.

Table 16-4. Risk Approximations for the New Jersey Monitoring Sites

Pollutant	Cancer URE ($\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	2015				2016			
			# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Risk Approximations		# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Risk Approximations	
					Cancer (in-a-million)	Noncancer (HQ)			Cancer (in-a-million)	Noncancer (HQ)
Camden, New Jersey - CSNJ										
Acetaldehyde	0.0000022	0.009	59/59	2.03 ± 0.25	4.47	0.23	60/60	2.65 ± 0.37	5.84	0.29
Benzene	0.0000078	0.03	61/61	0.86 ± 0.14	6.70	0.03	55/55	0.74 ± 0.11	5.80	0.02
Bromomethane	--	0.005	61/61	0.93 ± 0.74	--	0.19	55/55	0.41 ± 0.24	--	0.08
1,3-Butadiene	0.00003	0.002	61/61	0.09 ± 0.02	2.68	0.04	53/55	0.08 ± 0.02	2.47	0.04
Carbon Tetrachloride	0.000006	0.1	61/61	0.62 ± 0.02	3.74	0.01	55/55	0.63 ± 0.03	3.78	0.01
p-Dichlorobenzene	0.000011	0.8	34/61	0.05 ± 0.01	0.51	<0.01	29/55	0.06 ± 0.02	0.65	<0.01
1,2-Dichloroethane	0.000026	2.4	60/61	0.09 ± 0.01	2.22	<0.01	49/55	0.08 ± 0.01	2.01	<0.01
Ethylbenzene	0.0000025	1	61/61	0.42 ± 0.06	1.06	<0.01	55/55	0.47 ± 0.09	1.17	<0.01
Formaldehyde	0.000013	0.0098	59/59	3.57 ± 0.46	46.45	0.36	60/60	4.06 ± 0.43	52.82	0.41

-- = A Cancer URE or Noncancer RfC is not available.
NA = Not available because the criteria for calculating an annual average were not met.
NS = Sampling was not conducted during this time.

Table 16-4. Risk Approximations for the New Jersey Monitoring Sites (Continued)

Pollutant	Cancer URE ($\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	2015				2016			
			# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Risk Approximations		# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Risk Approximations	
					Cancer (in-a-million)	Noncancer (HQ)			Cancer (in-a-million)	Noncancer (HQ)
Chester, New Jersey - CHNJ										
Acetaldehyde	0.0000022	0.009	34/34	NA	NA	NA	60/60	1.16 ± 0.15	2.56	0.13
Benzene	0.0000078	0.03	55/55	0.40 ± 0.04	3.10	0.01	58/58	0.34 ± 0.04	2.66	0.01
1,3-Butadiene	0.00003	0.002	38/55	0.02 ± 0.01	0.66	0.01	34/58	0.02 ± <0.01	0.51	0.01
Carbon Tetrachloride	0.000006	0.1	55/55	0.64 ± 0.02	3.85	0.01	58/58	0.62 ± 0.03	3.69	0.01
1,2-Dichloroethane	0.000026	2.4	54/55	0.07 ± 0.01	1.78	<0.01	49/58	0.06 ± 0.01	1.66	<0.01
Formaldehyde	0.000013	0.0098	34/34	NA	NA	NA	60/60	2.16 ± 0.39	28.12	0.22
Elizabeth, New Jersey - ELNJ										
Acetaldehyde	0.0000022	0.009	60/60	2.49 ± 0.31	5.48	0.28	61/61	2.50 ± 0.26	5.49	0.28
Benzene	0.0000078	0.03	60/60	0.82 ± 0.08	6.39	0.03	60/60	0.83 ± 0.09	6.47	0.03
1,3-Butadiene	0.00003	0.002	60/60	0.12 ± 0.02	3.53	0.06	60/60	0.12 ± 0.02	3.72	0.06
Carbon Tetrachloride	0.000006	0.1	60/60	0.62 ± 0.03	3.70	0.01	60/60	0.62 ± 0.03	3.73	0.01
1,2-Dichloroethane	0.000026	2.4	57/60	0.07 ± 0.01	1.94	<0.01	55/60	0.08 ± 0.01	1.95	<0.01
Ethylbenzene	0.0000025	1	60/60	0.28 ± 0.04	0.69	<0.01	60/60	0.32 ± 0.04	0.80	<0.01
Formaldehyde	0.000013	0.0098	60/60	4.38 ± 0.68	56.99	0.45	61/61	4.43 ± 0.41	57.61	0.45

-- = A Cancer URE or Noncancer RfC is not available.
NA = Not available because the criteria for calculating an annual average were not met.
NS = Sampling was not conducted during this time.

Table 16-4. Risk Approximations for the New Jersey Monitoring Sites (Continued)

Pollutant	Cancer URE ($\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	2015				2016			
			# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Risk Approximations		# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Risk Approximations	
					Cancer (in-a-million)	Noncancer (HQ)			Cancer (in-a-million)	Noncancer (HQ)
North Brunswick, New Jersey - NBNJ										
Acetaldehyde	0.0000022	0.009	59/59	2.03 ± 0.20	4.48	0.23	NS	NS	NS	NS
Benzene	0.0000078	0.03	59/59	0.53 ± 0.07	4.13	0.02	NS	NS	NS	NS
1,3-Butadiene	0.00003	0.002	54/59	0.05 ± 0.01	1.46	0.02	NS	NS	NS	NS
Carbon Tetrachloride	0.000006	0.1	59/59	0.64 ± 0.02	3.85	0.01	NS	NS	NS	NS
1,2-Dichloroethane	0.000026	2.4	59/59	0.07 ± <0.01	1.89	<0.01	NS	NS	NS	NS
Formaldehyde	0.000013	0.0098	59/59	3.29 ± 0.56	42.77	0.34	NS	NS	NS	NS
East Brunswick, New Jersey - NRNJ										
Acetaldehyde	0.0000022	0.009	NS	NS	NS	NS	60/60	1.59 ± 0.19	3.51	0.18
Benzene	0.0000078	0.03	NS	NS	NS	NS	60/60	0.51 ± 0.07	4.00	0.02
1,3-Butadiene	0.00003	0.002	NS	NS	NS	NS	52/60	0.06 ± 0.01	1.76	0.03
Carbon Tetrachloride	0.000006	0.1	NS	NS	NS	NS	60/60	0.62 ± 0.03	3.73	0.01
1,2-Dichloroethane	0.000026	2.4	NS	NS	NS	NS	57/60	0.08 ± 0.01	2.09	<0.01
Formaldehyde	0.000013	0.0098	NS	NS	NS	NS	60/60	2.44 ± 0.30	31.70	0.25
Hexachloro-1,3-butadiene	0.000022	0.09	NS	NS	NS	NS	17/60	0.03 ± 0.01	0.60	<0.01

-- = A Cancer URE or Noncancer RfC is not available.
NA = Not available because the criteria for calculating an annual average were not met.
NS = Sampling was not conducted during this time.

Observations from Table 16-4 include the following:

- For CSNJ, the pollutants of interest with the highest annual average concentrations are formaldehyde and acetaldehyde. Formaldehyde has the highest cancer risk approximations for this site (46.45 in-a-million for 2015 and 52.82 in-a-million for 2015). The cancer risk approximations for formaldehyde are at least an order of magnitude higher than the cancer risk approximations for the other pollutants of interest for CSNJ. None of the pollutants of interest for CSNJ have noncancer hazard approximations greater than 1.0, indicating that adverse noncancer health effects are not expected from these individual pollutants. Formaldehyde is the pollutant with the highest noncancer hazard approximations for CSNJ (0.36 for 2015 and 0.41 for 2016).

- For CHNJ, the pollutants with the highest annual average concentrations for 2016 are formaldehyde, acetaldehyde, and carbon tetrachloride. Formaldehyde has the highest cancer risk approximation for 2016 (28.12 in-a-million). The 2016 cancer risk approximation for formaldehyde is at least an order of magnitude higher than the cancer risk approximations for the other pollutants of interest for CHNJ. None of the pollutants of interest for 2016 have noncancer hazard approximations greater than 1.0, indicating that adverse noncancer health effects are not expected from these individual pollutants. Formaldehyde is the pollutant with the highest noncancer hazard approximation for CHNJ (0.22). Annual average concentrations could not be calculated for the carbonyl compounds for 2015, and thus, only the VOCs have annual averages for 2015 in Table 16-4. The risk approximations for the VOCs for 2015 are similar to or slightly higher than the risk approximations for 2015.

- For ELNJ, the pollutants with the highest annual average concentrations are formaldehyde, acetaldehyde, and benzene. These three pollutants also have the highest cancer risk approximations for this site, although the cancer risk approximations for benzene are greater than the cancer risk approximations for acetaldehyde. ELNJ's cancer risk approximations for formaldehyde (56.99 in-a-million for 2015 and 57.61 in-a-million for 2016) are the highest cancer risk approximations calculated among the pollutants of interest for the New Jersey sites. None of the pollutants of interest for ELNJ have noncancer hazard approximations greater than 1.0, indicating that adverse noncancer health effects are not expected from these individual pollutants. Formaldehyde is the pollutant with the highest noncancer hazard approximations for ELNJ (0.45 for both years).

- For both NBNJ and NRNJ, the pollutants with the highest annual average concentrations are formaldehyde, acetaldehyde, carbon tetrachloride, and benzene. Formaldehyde has the highest cancer risk approximation for each site (42.77 in-a-million for NBNJ in 2015 and 31.70 in-a-million for NRNJ in 2016); the cancer risk approximations for the remaining pollutants of interest are at least an order of magnitude lower. None of the pollutants of interest for either site have noncancer hazard approximations greater than 1.0, indicating that adverse noncancer health effects are not expected from these individual pollutants. Formaldehyde is the pollutant with the highest noncancer hazard approximations for NBNJ and NRNJ (0.34 and 0.25, respectively).

16.4.2 Risk-Based Emissions Assessment

In addition to the risk-based screening discussed above, this section presents an evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 16-5 presents the 10 pollutants with the highest emissions from the 2014 NEI (version 1) that have cancer toxicity factors. Table 16-5 also presents the 10 pollutants with the highest toxicity-weighted emissions, based on the weighting schema described in Section 3.4.2.4. Lastly, Table 16-5 provides the pollutants with the highest cancer risk approximations (in-a-million) for each New Jersey site, as presented in Table 16-4. Cancer risk approximations for 2015 are presented in green while approximations for 2016 are in white. The emissions, toxicity-weighted emissions, and cancer risk approximations are shown in descending order in Table 16-5. Table 16-6 presents similar information but is limited to those pollutants with noncancer toxicity factors.

Because not all pollutants have both cancer and noncancer toxicity factors, the highest emitted pollutants in the cancer table may be different from the noncancer table, although the actual quantity of emissions is the same. The cancer risk and noncancer hazard approximations based on each site's annual averages are limited to the pollutants of interest identified for each site. In addition, the cancer risk and noncancer hazard approximations are limited to those pollutants with enough data to meet the criteria for annual averages to be calculated. A more in-depth discussion of this analysis is provided in Section 3.4.2.4. Similar to the cancer risk and noncancer hazard approximations provided in Section 16.4.1, this analysis may help policy-makers prioritize their air monitoring activities.

Table 16-5. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the New Jersey Monitoring Sites

Top 10 Total Emissions for Pollutants with Cancer UREs (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Camden, New Jersey (Camden County) - CSNJ					
Benzene	99.22	Formaldehyde	1.04E-03	Formaldehyde	52.82
Formaldehyde	79.81	Benzene	7.74E-04	Formaldehyde	46.45
Ethylbenzene	50.34	1,3-Butadiene	4.90E-04	Benzene	6.70
Acetaldehyde	44.10	Naphthalene	2.73E-04	Acetaldehyde	5.84
1,3-Butadiene	16.32	POM, Group 2b	1.75E-04	Benzene	5.80
Naphthalene	8.03	POM, Group 5a	1.35E-04	Acetaldehyde	4.47
POM, Group 2b	1.99	POM, Group 2d	1.33E-04	Carbon Tetrachloride	3.78
POM, Group 2d	1.51	Ethylbenzene	1.26E-04	Carbon Tetrachloride	3.74
Trichloroethylene	0.68	Acetaldehyde	9.70E-05	1,3-Butadiene	2.68
Acrylonitrile	0.22	Arsenic, PM	8.84E-05	1,3-Butadiene	2.47
Chester, New Jersey (Morris County) - CHNJ					
Benzene	146.18	Formaldehyde	1.70E-03	Formaldehyde	28.12
Formaldehyde	130.73	Benzene	1.14E-03	Carbon Tetrachloride	3.85
Ethylbenzene	73.50	1,3-Butadiene	7.28E-04	Carbon Tetrachloride	3.69
Acetaldehyde	67.44	Naphthalene	4.42E-04	Benzene	3.10
1,3-Butadiene	24.26	POM, Group 2b	2.72E-04	Benzene	2.66
Naphthalene	12.99	POM, Group 5a	2.32E-04	Acetaldehyde	2.56
Dichloromethane	4.47	POM, Group 2d	2.09E-04	1,2-Dichloroethane	1.78
POM, Group 2b	3.09	Ethylbenzene	1.84E-04	1,2-Dichloroethane	1.66
POM, Group 2d	2.37	Acetaldehyde	1.48E-04	1,3-Butadiene	0.66
Trichloroethylene	1.10	Arsenic, PM	1.29E-04	1,3-Butadiene	0.51

[1]Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Table 16-5. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the New Jersey Monitoring Sites (Continued)

Top 10 Total Emissions for Pollutants with Cancer UREs (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Annual Average Concentrations (Site-Specific) [1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Elizabeth, New Jersey (Union County) - ELNJ					
Formaldehyde	124.94	Formaldehyde	1.62E-03	Formaldehyde	57.61
Benzene	111.35	Benzene	8.69E-04	Formaldehyde	56.99
Acetaldehyde	57.68	1,3-Butadiene	5.42E-04	Benzene	6.47
Ethylbenzene	57.15	Naphthalene	3.70E-04	Benzene	6.39
1,3-Butadiene	18.08	POM, Group 2b	1.94E-04	Acetaldehyde	5.49
Naphthalene	10.89	Nickel, PM	1.84E-04	Acetaldehyde	5.48
POM, Group 2b	2.20	Arsenic, PM	1.72E-04	Carbon Tetrachloride	3.73
POM, Group 2d	1.77	POM, Group 2d	1.56E-04	1,3-Butadiene	3.72
Dichloromethane	1.36	POM, Group 5a	1.55E-04	Carbon Tetrachloride	3.70
Trichloroethylene	1.09	Ethylbenzene	1.43E-04	1,3-Butadiene	3.53
North Brunswick, New Jersey (Middlesex County) - NBNJ					
Formaldehyde	191.17	Formaldehyde	2.49E-03	Formaldehyde	42.77
Benzene	181.78	Ethylene oxide	1.85E-03	Acetaldehyde	4.48
Acetaldehyde	90.56	Benzene	1.42E-03	Benzene	4.13
Ethylbenzene	89.72	1,3-Butadiene	8.49E-04	Carbon Tetrachloride	3.85
1,3-Butadiene	28.31	Naphthalene	6.13E-04	1,2-Dichloroethane	1.89
Naphthalene	18.04	POM, Group 2b	3.31E-04	1,3-Butadiene	1.46
Dichloromethane	10.35	POM, Group 5a	2.74E-04		
POM, Group 2b	3.76	POM, Group 2d	2.65E-04		
POM, Group 2d	3.01	Ethylbenzene	2.24E-04		
Trichloroethylene	1.83	Acetaldehyde	1.99E-04		

[1]Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Table 16-5. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the New Jersey Monitoring Sites (Continued)

Top 10 Total Emissions for Pollutants with Cancer UREs (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Annual Average Concentrations (Site-Specific) [1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
East Brunswick, New Jersey (Middlesex County) - NRNJ					
Formaldehyde	191.17	Formaldehyde	2.49E-03	Formaldehyde	31.70
Benzene	181.78	Ethylene oxide	1.85E-03	Benzene	4.00
Acetaldehyde	90.56	Benzene	1.42E-03	Carbon Tetrachloride	3.73
Ethylbenzene	89.72	1,3-Butadiene	8.49E-04	Acetaldehyde	3.51
1,3-Butadiene	28.31	Naphthalene	6.13E-04	1,2-Dichloroethane	2.09
Naphthalene	18.04	POM, Group 2b	3.31E-04	1,3-Butadiene	1.76
Dichloromethane	10.35	POM, Group 5a	2.74E-04	Hexachloro-1,3-butadiene	0.60
POM, Group 2b	3.76	POM, Group 2d	2.65E-04		
POM, Group 2d	3.01	Ethylbenzene	2.24E-04		
Trichloroethylene	1.83	Acetaldehyde	1.99E-04		

[1] Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Table 16-6. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the New Jersey Monitoring Sites

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Hazard Approximation (HQ)**
Camden, New Jersey (Camden County) - CSNJ					
Toluene	374.94	Acrolein	300,819.57	Formaldehyde	0.41
Methanol	363.96	1,3-Butadiene	8,161.97	Formaldehyde	0.36
Xylenes	181.81	Formaldehyde	8,143.65	Acetaldehyde	0.29
Benzene	99.22	Acetaldehyde	4,900.03	Acetaldehyde	0.23
Formaldehyde	79.81	Benzene	3,307.25	Bromomethane	0.19
Hexane	66.08	Naphthalene	2,677.40	Bromomethane	0.08
Ethylbenzene	50.34	Cadmium, PM	2,533.67	1,3-Butadiene	0.04
Acetaldehyde	44.10	Xylenes	1,818.11	1,3-Butadiene	0.04
Hydrochloric acid	32.85	Hydrochloric acid	1,642.29	Benzene	0.03
Ethylene glycol	27.10	Lead, PM	1,517.16	Benzene	0.02
Chester, New Jersey (Morris County) - CHNJ					
Toluene	501.59	Acrolein	412,708.27	Formaldehyde	0.22
Methanol	353.16	Formaldehyde	13,339.43	Acetaldehyde	0.13
Xylenes	267.79	1,3-Butadiene	12,129.01	Benzene	0.01
Benzene	146.18	Acetaldehyde	7,493.84	Benzene	0.01
Formaldehyde	130.73	Benzene	4,872.78	1,3-Butadiene	0.01
Hexane	87.15	Naphthalene	4,329.86	1,3-Butadiene	0.01
Ethylbenzene	73.50	Xylenes	2,677.85	Carbon Tetrachloride	0.01
Acetaldehyde	67.44	Nickel, PM	2,090.44	Carbon Tetrachloride	0.01
Ethylene glycol	28.12	Arsenic, PM	1,996.26	1,2-Dichloroethane	<0.01
1,3-Butadiene	24.26	Lead, PM	1,989.59	1,2-Dichloroethane	<0.01

[1]Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Table 16-6. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the New Jersey Monitoring Sites (Continued)

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific) [1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Hazard Approximation (HQ)**
Elizabeth, New Jersey (Union County) - ELNJ					
Toluene	429.29	Acrolein	324,893.75	Formaldehyde	0.45
Methanol	395.60	Cyanide Compounds, PM	38,375.00	Formaldehyde	0.45
Xylenes	209.50	Formaldehyde	12,749.01	Acetaldehyde	0.28
Formaldehyde	124.94	1,3-Butadiene	9,038.25	Acetaldehyde	0.28
Benzene	111.35	Acetaldehyde	6,408.71	1,3-Butadiene	0.06
Hexane	75.26	Chlorine	4,376.67	1,3-Butadiene	0.06
Acetaldehyde	57.68	Nickel, PM	4,269.72	Benzene	0.03
Ethylbenzene	57.15	Benzene	3,711.66	Benzene	0.03
Ethylene glycol	31.63	Naphthalene	3,628.65	Carbon Tetrachloride	0.01
Cyanide Compounds, PM	30.70	Arsenic, PM	2,670.68	Carbon Tetrachloride	0.01
North Brunswick, New Jersey (Middlesex County) - NBNJ					
Toluene	662.03	Acrolein	554,943.51	Formaldehyde	0.34
Methanol	597.44	Formaldehyde	19,506.78	Acetaldehyde	0.23
Xylenes	333.05	1,3-Butadiene	14,156.30	1,3-Butadiene	0.02
Formaldehyde	191.17	Acetaldehyde	10,062.20	Benzene	0.02
Benzene	181.78	Benzene	6,059.50	Carbon Tetrachloride	0.01
Hexane	130.27	Naphthalene	6,012.36	1,2-Dichloroethane	<0.01
Acetaldehyde	90.56	Titanium tetrachloride	5,095.00		
Ethylbenzene	89.72	Lead, PM	3,737.36		
Ethylene glycol	45.93	Cadmium, PM	3,669.89		
Glycol ethers, gas	41.32	Xylenes	3,330.51		

[1]Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Table 16-6. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the New Jersey Monitoring Sites (Continued)

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific) [1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Hazard Approximation (HQ)**
East Brunswick, New Jersey (Middlesex County) - NRNJ					
Toluene	662.03	Acrolein	554,943.51	Formaldehyde	0.25
Methanol	597.44	Formaldehyde	19,506.78	Acetaldehyde	0.18
Xylenes	333.05	1,3-Butadiene	14,156.30	1,3-Butadiene	0.03
Formaldehyde	191.17	Acetaldehyde	10,062.20	Benzene	0.02
Benzene	181.78	Benzene	6,059.50	Carbon Tetrachloride	0.01
Hexane	130.27	Naphthalene	6,012.36	Hexachloro-1,3-butadiene	<0.01
Acetaldehyde	90.56	Titanium tetrachloride	5,095.00	1,2-Dichloroethane	<0.01
Ethylbenzene	89.72	Lead, PM	3,737.36		
Ethylene glycol	45.93	Cadmium, PM	3,669.89		
Glycol ethers, gas	41.32	Xylenes	3,330.51		

[1] Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Observations from Table 16-5 include the following:

- Benzene, formaldehyde, ethylbenzene, and acetaldehyde are the highest emitted pollutants with cancer UREs in all four New Jersey counties with NMP sites, although the order varies. In fact, these four counties have eight pollutants in common among the highest pollutants emitted.

- Formaldehyde, benzene, and 1,3-butadiene are the pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) for three of the four New Jersey counties, with Middlesex County (NBNJ and NRNJ) as the exception. In Middlesex County, formaldehyde also has the highest toxicity-weighted emissions, followed by ethylene oxide prior to benzene and 1,3-butadiene.

- Eight of the 10 highest emitted pollutants in Camden, Morris, and Middlesex Counties also have the highest toxicity-weighted emissions. Seven of the highest emitted pollutants in Union County also have the highest toxicity-weighted emissions.

- Formaldehyde, benzene, acetaldehyde, and 1,3-butadiene are among the pollutants of interest with the highest cancer risk approximations for CSNJ and also appear on both emissions-based lists. Carbon tetrachloride is also among the pollutants with the highest cancer risk approximations for CSNJ, although this pollutant appears on neither emissions-based list for Camden County.

- Formaldehyde, benzene, acetaldehyde, and 1,3-butadiene are among the pollutants of interest with the highest cancer risk approximations for CHNJ and also appear on both emissions-based lists. Carbon tetrachloride and 1,2-dichloroethane are also among the pollutants with the highest cancer risk approximations for CHNJ, although these pollutants appear on neither emissions-based list for Morris County.

- Formaldehyde is the pollutant with the highest emissions in Union County, the highest toxicity-weighted emissions, and has the highest cancer risk approximations for ELNJ. In addition to formaldehyde, benzene and 1,3-butadiene also appear on all three lists. Acetaldehyde is also among the pollutants with the highest cancer risk approximations for ELNJ, and is among the highest emitted, but is not among those with the highest toxicity-weighted emissions. Carbon tetrachloride is also among the pollutants of interest with the highest cancer risk approximations for ELNJ, although this pollutant appears on neither emissions-based list for Union County.

- Formaldehyde also tops all three lists for Middlesex County and NBNJ and NRNJ. In addition to formaldehyde, benzene, acetaldehyde, and 1,3-butadiene are among the pollutants with the highest cancer risk approximations for both of these sites and also appear on both emissions-based lists for Middlesex County. Carbon tetrachloride and 1,2-dichloroethane are also among the pollutants of interest with the highest cancer risk approximations for NBNJ and NRNJ, although these pollutants appear on neither emissions-based list for Middlesex County. This is also true for hexachloro-1,3-butadiene for NRNJ.

Observations from Table 16-6 include the following:

- Toluene, methanol, and xylenes are the highest emitted pollutants with noncancer RfCs in all four New Jersey counties with NMP sites.

- Acrolein is the pollutant with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) for all four New Jersey counties but is not among the highest emitted pollutants for any of the New Jersey counties (acrolein ranks between 15th and 17th for these counties). Although acrolein was sampled for at all five sites, this pollutant was excluded from the pollutant of interest designation, and thus, subsequent risk-based screening evaluations, due to questions about the consistency and reliability of the measurements, as discussed in Section 3.2. Formaldehyde and 1,3-butadiene are the pollutants with the second and third highest toxicity-weighted emissions in three of the four counties. For Union County (ELNJ), cyanide compounds rank higher than these two pollutants for this county's toxicity-weighted emissions.

- Between four and five of the 10 highest emitted pollutants also have the highest toxicity-weighted emissions for each of the New Jersey counties.

- Formaldehyde has the highest noncancer hazard approximations for each of the New Jersey sites and appears on both emissions-based lists for each county.

- In addition to formaldehyde, acetaldehyde and benzene are pollutants of interest for CSNJ that also appear on both emissions-based lists for Camden County. 1,3-Butadiene is another pollutant of interest for CSNJ that appears among those with the highest toxicity-weighted emissions but is not among the highest emitted in Camden County (of the pollutants with noncancer RfCs). Bromomethane is a pollutant of interest for CSNJ that appears on neither emissions-based list.

- In addition to formaldehyde, benzene, acetaldehyde, and 1,3-butadiene are among the pollutants of interest with the highest noncancer hazard approximations for CHNJ and also appear on both emissions-based lists. Carbon tetrachloride and 1,2-dichloroethane are also among the pollutants with the highest noncancer hazard approximations for CHNJ, although these pollutants appear on neither emissions-based list for Morris County.

- In addition to formaldehyde, acetaldehyde and benzene are pollutants of interest for ELNJ that also appear on both emissions-based lists for Union County. 1,3-Butadiene is another pollutant of interest for ELNJ that appears among those with the highest toxicity-weighted emissions but is not among the highest emitted in Union County (of the pollutants with noncancer RfCs). Carbon tetrachloride is a pollutant of interest for ELNJ that appears on neither emissions-based list.

- In addition to formaldehyde, acetaldehyde and benzene are pollutants of interest for NBNJ and NRNJ that also appear on both emissions-based lists for Middlesex County. 1,3-Butadiene is another pollutant of interest for these two sites that appears among those with the highest toxicity-weighted emissions but is not among the highest emitted in Middlesex County (of the pollutants with noncancer RfCs). Carbon

tetrachloride and 1,2-dichloroethane are also pollutants of interest for NBNJ and NRNJ but appear on neither emissions-based list. This is also true for hexachloro-1,3-butadiene for NRNJ.

16.5 Summary of the 2015-2016 Monitoring Data for the New Jersey Monitoring Sites

Results from several of the data analyses described in this section include the following:

- *Concentrations of 15 pollutants failed at least one screen for CSNJ; nine pollutants failed screens for CHNJ; 11 pollutants failed screens for ELNJ; 10 pollutants failed screens for NBNJ; and 10 pollutants failed screens for NRNJ.*

- *Formaldehyde and acetaldehyde had the highest annual average concentrations for each of the New Jersey sites, where they could be calculated. Among the VOCs, benzene and carbon tetrachloride had the highest annual average concentrations for each site, with one exception. Bromomethane had the highest annual average concentration for CSNJ in 2015. The highest bromomethane concentrations across the program were measured at CSNJ.*

- *ELNJ is the longest running NMP site participating under the NMP. Concentrations of benzene have decreased significantly at this site since the onset of sampling. This is also true of ethylbenzene, although concentrations have leveled out in the last few years. Concentrations of benzene also have decreasing trends at CHNJ and, to a lesser extent, NBNJ.*

- *Formaldehyde has the highest cancer risk approximations among the New Jersey sites' pollutants of interest, where they could be calculated. None of the pollutants of interest for these sites have noncancer hazard approximations greater than an HQ of 1.0.*

17.0 Sites in New York

This section summarizes those data from samples collected at the NATTS sites in New York and generated by ERG, EPA's contract laboratory for the NMP, over the 2015 and 2016 monitoring efforts. This section also examines the spatial and temporal characteristics of the ambient monitoring concentrations and reviews them through the context of risk. Readers are encouraged to refer to Sections 1 through 4 for detailed discussions and definitions regarding the various data analyses presented below.

Data generated by sources other than ERG, EPA's contract laboratory for the NMP, are not included in the data analyses contained in this report.

17.1 Site Characterization

This section characterizes the New York monitoring sites by providing a description of the nearby area surrounding each monitoring site; plotting emissions sources surrounding the monitoring sites; and presenting traffic data and other characterizing information for each site. This information is provided to give the reader insight regarding factors that may influence the air quality near the sites and assist in the interpretation of the ambient monitoring measurements.

One New York monitoring site is located in the Bronx Borough of New York City (BXNY) and one is located in Rochester (ROCH). Figure 17-1 presents a composite satellite image retrieved from ArcGIS Explorer showing the BXNY monitoring site and its immediate surroundings. Figure 17-2 identifies nearby point source emissions locations by source category, as reported in the 2014 NEI for point sources, version 1. Note that only sources within 10 miles of BXNY are included in the facility counts provided in Figure 17-2. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have a direct effect on the air quality at the monitoring site. Further, this boundary provides both the proximity of emissions sources to the monitoring site as well as the quantity of such sources within a given distance of the site. Sources outside the 10-mile boundary are still visible on the map for reference but have been grayed out to emphasize emissions sources within the boundary. Figures 17-3 and 17-4 are the composite satellite image and emissions sources map for ROCH. Table 17-1 provides supplemental geographical information such as land use, location setting, and locational coordinates. Each figure and table is discussed in detail in the paragraphs that follow.

Figure 17-1. Bronx, New York (BXNY) Monitoring Site

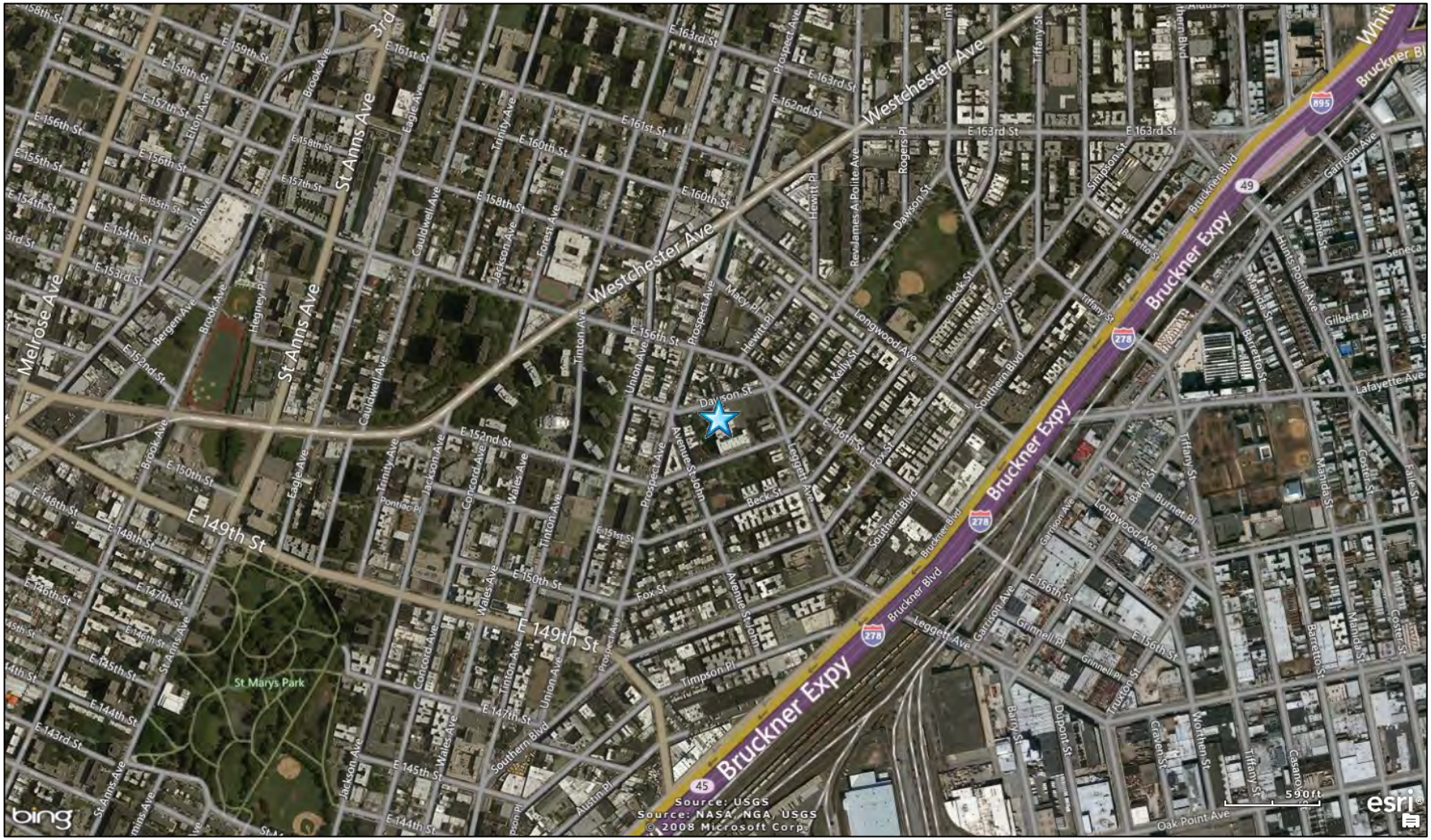


Figure 17-2. NEI Point Sources Located Within 10 Miles of BXNY

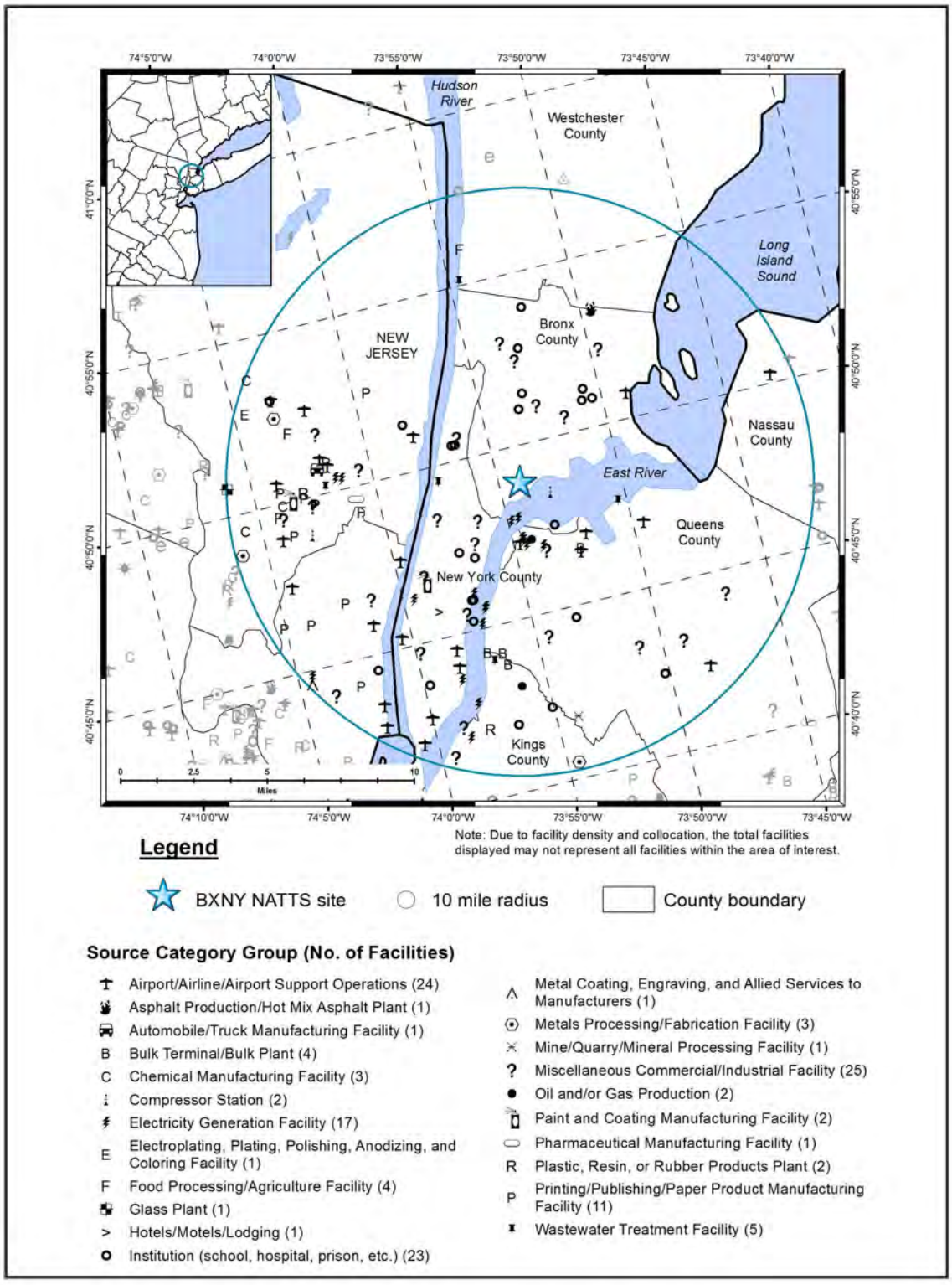


Figure 17-3. Rochester, New York (ROCH) Monitoring Site

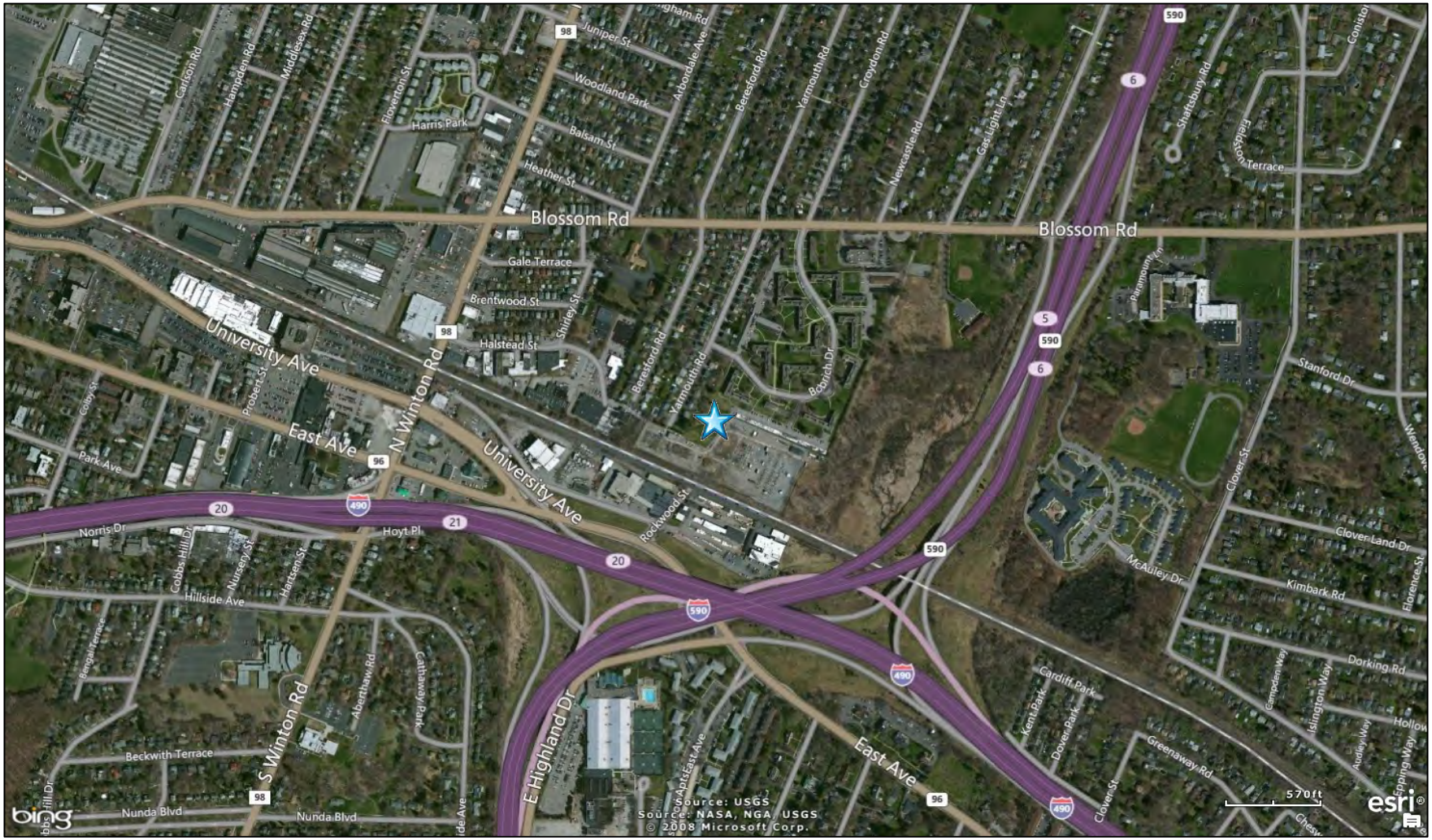


Figure 17-4. NEI Point Sources Located Within 10 Miles of ROCH

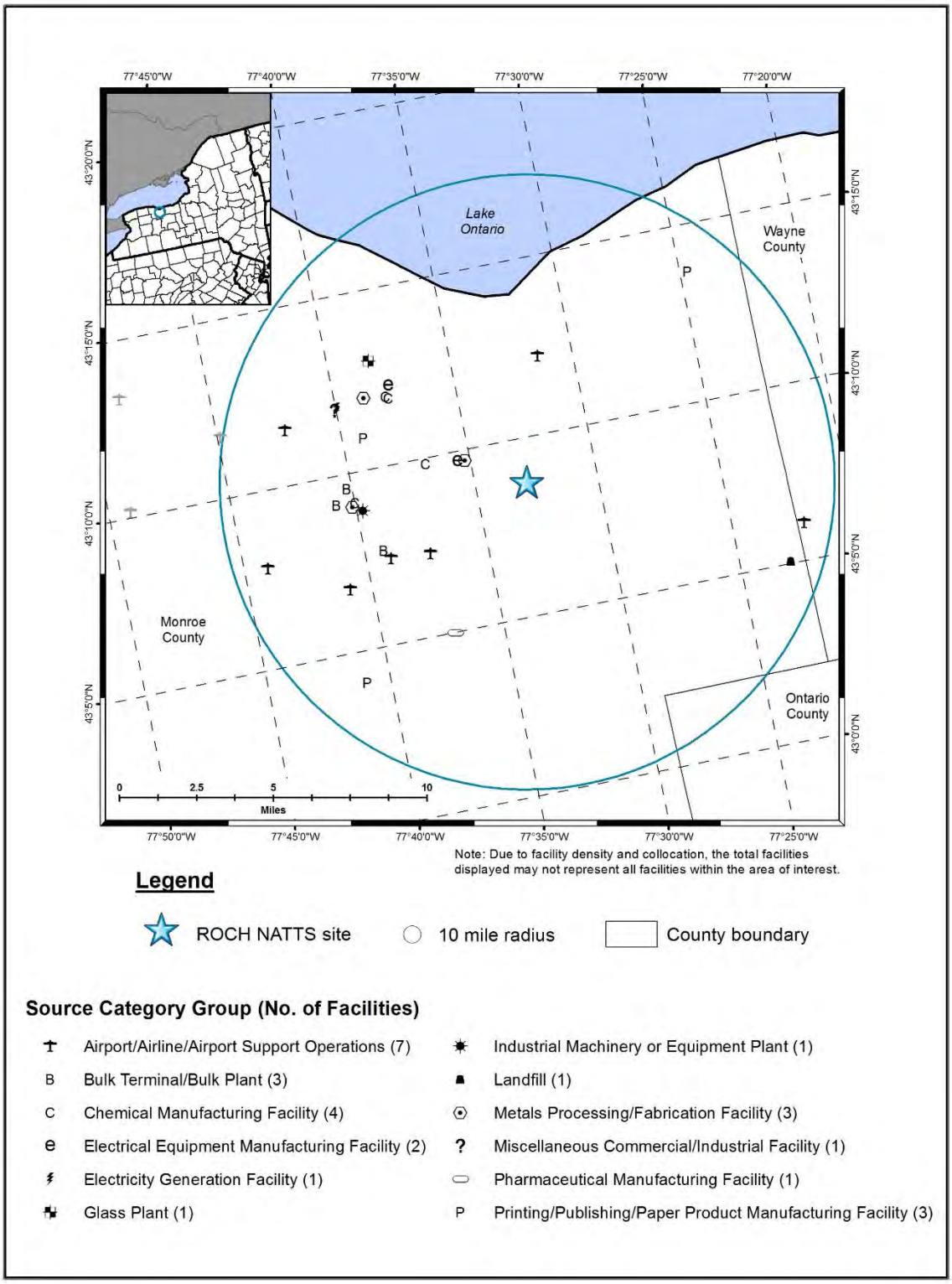


Table 17-1. Geographical Information for the New York Monitoring Sites

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Annual Average Daily Traffic[1]	Intersection Used for Traffic Data
BXNY	36-005-0110	New York	Bronx	New York-Newark-Jersey City, NY-NJ-PA	40.816180, -73.902000	Residential	Urban/City Center	100,898	I-278 between I-87 & I-895
ROCH	36-055-1007	Rochester	Monroe	Rochester, NY	43.146180, -77.548170	Residential	Urban/City Center	85,833	I-490 at I-590

[1]AADT reflects 2015 data (NYS DOT, 2015)
BOLD ITALICS = EPA-designated NATTS Site

BXNY is located on the property of Public School 52 (PS 52) in Bronx, New York, northeast of Manhattan. The site was established in 1999 and is considered one of the premier particulate sampling sites in New York City and is the Bronx (#1) NATTS site. The surrounding area is urban and residential, as shown in Figure 17-1. The Bruckner Expressway (I-278) is located a few blocks east of the monitoring site and other heavily traveled roadways are also located within a few miles of the site. A freight yard and other industries lie on the southeast and south side of I-278, part of which can be seen in the lower right-hand side of Figure 17-1. BXNY is just over one-half mile from the East River at its closest point.

Figure 17-2 shows the numerous point sources that are located within 10 miles of BXNY, with a majority of the emissions sources located to the south and west of the site. The source categories with the greatest number of emissions sources surrounding the site include institutions such as hospitals, schools, and prisons; airport and airport support operations, which include airports and related operations as well as small runways and heliports, such as those associated with hospitals or television stations; electricity generation via combustion; and the miscellaneous commercial and industrial facility source category. The point source closest to BXNY is a compressor station.

ROCH is located at a power substation on the east side of Rochester, in western New York. Rochester is approximately halfway between Syracuse and Buffalo, with Lake Ontario situated to the north. Although the area north and west of the site is primarily residential, as shown in Figure 17-3, a rail line transverses the area just south of the site, and I-590 and I-490 intersect farther south with commercial areas adjacent to this corridor. The site is used by researchers from several universities for short-term air monitoring studies and is the Rochester NATTS site.

As Figure 17-4 shows, the relatively few point sources within 10 miles of ROCH are located primarily on the west half of the 10-mile boundary. The airport and airport support operations source category is the source category with the greatest number of emissions sources surrounding ROCH, although there are also bulk plants/bulk terminals, chemical manufacturers, metals processors/fabricators, electrical equipment manufactures, and printing, publishing, and paper product manufacturers nearby, to name a few. The closest sources to ROCH are a metals processing and fabrication facility and an electrical equipment manufacturer.

In addition to providing city, county, CBSA, and land use/location setting information, Table 17-1 also contains traffic volume information for each site as well as the location for which the traffic volume was obtained. This information is provided because emissions from motor vehicles can significantly affect concentrations measured at a given monitoring site. Traffic volume is higher near BXNY than ROCH, which rank 12th and 14th, respectively, among NMP sites, with both in the upper third compared to other NMP sites. The traffic estimate for BXNY is for I-278 between I-87 and I-895; the traffic estimate for ROCH is provided for I-490 at I-590.

17.2 Pollutants of Interest

The risk-based screening process described in Section 3.2 was performed for each site to identify site-specific "pollutants of interest," which allows analysts and readers to focus on a subset of pollutants through the context of risk. For each site, each pollutant's preprocessed daily measurement was compared to its associated risk screening value. If the concentration was greater than the risk screening value, then the concentration "failed the screen." The site-specific results of this risk-based screening process are presented in Table 17-2 and incorporate measurements from both 2015 and 2016. Pollutants of interest are those for which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens and are shaded in gray in Table 17-2. It is important to note which pollutants were sampled for at each site when reviewing the results of this analysis. PAHs were sampled for at both New York sites.

Observations from Table 17-3 include the following:

- Concentrations of six pollutants failed screens for BXNY; nearly 25 percent of concentrations for these six pollutants were greater than their associated risk screening value (or failed screens). BXNY is one of only two NMP sites at which a concentration of acenaphthylene failed a screen.

- Four of the six PAHs that failed screens were identified as pollutants of interest for BXNY.

- Concentrations of eight pollutants failed screens for ROCH; 23 percent of concentrations for these eight pollutants were greater than their associated risk screening value (or failed screens). ROCH is the only site for which benzo(a)anthracene, benzo(b)fluoranthene, and dibenz(a,h)anthracene failed at least one screen. For each of these three pollutants, the concentration that failed a screen was measured on the same day: July 23, 2015.

- Four of the eight pollutants contributed to 95 percent of failed screens for ROCH and therefore were identified as pollutants of interest for this site.

- BXNY and ROCH have three pollutants of interest in common: naphthalene, acenaphthene, and fluorene. Naphthalene failed the majority of screens for each site, accounting for 72 percent of failed screens for BXNY and 40 percent of failed screens for ROCH. Acenaphthene and fluorene together account for 33 failed screens for BXNY and 100 failed screens for ROCH. Thus, the number of failed screens of acenaphthene and fluorene is three times greater for ROCH than BXNY. A similar observation was made in the 2014 NMP report. Concentrations of acenaphthene and fluorene measured at ROCH failed the most screens of any NMP site sampling these pollutants.

Table 17-2. 2015-2016 Risk-Based Screening Results for the New York Monitoring Sites

Pollutant	Screening Value ($\mu g/m^3$)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Bronx, New York - BXNY						
Naphthalene	0.029	118	120	98.33	72.39	72.39
Fluorene	0.011	19	102	18.63	11.66	84.05
Acenaphthene	0.011	14	117	11.97	8.59	92.64
Benzo(a)pyrene	0.00057	7	117	5.98	4.29	96.93
Acenaphthylene	0.011	3	84	3.57	1.84	98.77
Fluoranthene	0.011	2	120	1.67	1.23	100.00
Total		163	660	24.70		
Rochester, New York - ROCH						
Naphthalene	0.029	82	116	70.69	39.61	39.61
Acenaphthene	0.011	51	108	47.22	24.64	64.25
Fluorene	0.011	49	104	47.12	23.67	87.92
Fluoranthene	0.011	20	116	17.24	9.66	97.58
Benzo(a)pyrene	0.00057	2	114	1.75	0.97	98.55
Benzo(a)anthracene	0.0057	1	114	0.88	0.48	99.03
Benzo(b)fluoranthene	0.0057	1	114	0.88	0.48	99.52
Dibenz(a,h)anthracene	0.00052	1	96	1.04	0.48	100.00
Total		207	882	23.47		

For each of the data analyses described in the remaining sections, the focus is on the site-specific pollutants of interest identified via the risk-based screening process, as described in Section 3.4.2.

17.3 Concentrations

This section presents various concentration averages used to characterize air toxics concentration levels at the New York monitoring sites. Where applicable, the following calculations and data analyses were performed for each of the site-specific pollutants of interest:

- Time period-based concentration averages (quarterly and annual) are provided for each monitoring site for each year.
- The range of measurements and annual average concentrations are presented graphically for each site to illustrate how the site's concentrations compare to the program-level averages, as presented in Section 4.1.
- Concentration averages and other statistical metrics for 2015, 2016, and from previous years of monitoring are presented in order to characterize concentration trends at each site.

Each data analysis is performed where the applicable criteria are met (as specified in the appropriate sections discussed below) and is limited to the site-specific pollutants of interest. However, site-specific statistical summaries for all pollutants sampled for at BXNY and ROCH are provided in Appendix N.

17.3.1 2015 and 2016 Concentration Averages

Quarterly and annual concentration averages for 2015 and 2016 were calculated for the pollutants of interest for each New York site, as described in Section 3.1. The *quarterly average concentration* of a particular pollutant is simply the average concentration of the preprocessed daily measurements over a given calendar quarter. Quarterly average concentrations include the substitution of zeros for all non-detects. A site must have a minimum of 75 percent valid samples compared to the total number of samples possible within a given calendar quarter for a quarterly average to be calculated. An *annual average concentration* includes all measured detections and substituted zeros for non-detects for an entire year of sampling. Annual averages were calculated for pollutants where three valid quarterly averages could be calculated for a given year and where method completeness was greater than or equal to 85 percent, as presented in Section 2.4. Quarterly and annual average concentrations for the pollutants of interest for the New York monitoring sites are presented in Table 17-3, where applicable. Note that if a pollutant was not detected in a given calendar quarter, the quarterly average simply reflects "0" because only zeros substituted for non-detects were factored into the quarterly average concentration.

Table 17-3. Quarterly and Annual Average Concentrations of the Pollutants of Interest for the New York Monitoring Sites

Pollutant	2015 # of Detects/ # >MDL/ # Samples	2015 Q1 Avg (ng/m^3)	2015 Q2 Avg (ng/m^3)	2015 Q3 Avg (ng/m^3)	2015 Q4 Avg (ng/m^3)	2015 Annual Average (ng/m^3)	2016 # of Detects/ # >MDL/ # Samples	2016 Q1 Avg (ng/m^3)	2016 Q2 Avg (ng/m^3)	2016 Q3 Avg (ng/m^3)	2016 Q4 Avg (ng/m^3)	2016 Annual Average (ng/m^3)
Bronx, New York - BXNY												
Acenaphthene	57/57/59	1.81 ± 0.64	7.22 ± 2.20	10.00 ± 1.94	3.33 ± 0.96	5.65 ± 1.12	60/60/61	1.92 ± 0.57	6.06 ± 2.05	9.44 ± 2.53	3.94 ± 1.91	5.28 ± 1.14
Benzo(a)pyrene	57/29/59	0.36 ± 0.16	0.14 ± 0.03	0.14 ± 0.08	0.21 ± 0.11	0.21 ± 0.05	60/42/61	0.27 ± 0.15	0.15 ± 0.09	0.12 ± 0.06	0.12 ± 0.06	0.17 ± 0.05
Fluorene	53/53/59	3.18 ± 0.82	7.78 ± 1.89	12.02 ± 2.74	3.22 ± 1.45	6.61 ± 1.30	49/49/61	1.40 ± 1.02	6.81 ± 2.62	11.54 ± 3.05	4.79 ± 1.85	6.06 ± 1.41
Naphthalene	59/59/59	110.32 ± 29.94	107.87 ± 16.14	115.61 ± 20.43	118.20 ± 35.06	113.05 ± 12.40	61/61/61	92.79 ± 26.38	105.85 ± 22.24	88.48 ± 17.44	86.08 ± 24.25	93.29 ± 10.96
Rochester, New York - ROCH												
Acenaphthene	53/53/56	2.77 ± 2.17	24.99 ± 8.70	34.20 ± 3.93	5.74 ± 1.77	17.37 ± 4.25	55/55/60	2.09 ± 1.10	15.80 ± 7.38	33.12 ± 4.27	4.39 ± 2.33	13.81 ± 3.80
Fluoranthene	56/56/56	1.21 ± 0.53	8.51 ± 3.15	10.61 ± 2.90	1.99 ± 0.66	5.73 ± 1.51	60/60/60	1.46 ± 0.49	7.01 ± 3.55	9.92 ± 2.59	1.78 ± 0.51	5.03 ± 1.39
Fluorene	53/53/56	2.61 ± 1.37	18.25 ± 5.73	25.76 ± 3.34	4.43 ± 1.73	13.07 ± 3.08	51/51/60	1.83 ± 1.07	13.86 ± 6.15	27.36 ± 3.77	3.91 ± 1.50	11.71 ± 3.14
Naphthalene	56/56/56	37.52 ± 9.52	58.68 ± 13.04	88.33 ± 8.08	47.40 ± 10.19	58.54 ± 7.04	60/60/60	36.83 ± 12.52	53.04 ± 16.70	80.34 ± 11.54	33.67 ± 9.79	51.02 ± 7.73

Observations for BXNY from Table 17-3 include the following:

- Of the pollutants of interest for BXNY, naphthalene has the highest annual average concentrations, benzo(a)pyrene has the lowest, and the annual averages for acenaphthene and fluorene are similar to each other.

- Concentrations of naphthalene measured at BXNY range from 19.0 ng/m^3 to 278 ng/m^3, with five of the six naphthalene concentrations greater than 200 ng/m^3 measured at BXNY in 2015. Concentrations of naphthalene measured in 2015 appear higher than those measured in 2016, based on the annual average concentrations, although the difference is not statistically significant. Each of the quarterly average concentrations has considerable variability associated with it, especially those calculated for the first and fourth quarters of each year.

- Concentrations of benzo(a)pyrene measured at BXNY span two orders of magnitude, ranging from 0.0219 ng/m^3 to 1.17 ng/m^3, and include three non-detects. The maximum benzo(a)pyrene concentration measured each year was measured during the first quarter (1.17 ng/m^3, in January 2016 and 1.08 ng/m^3 in February 2015). For both years, the first quarter average concentration is the highest among the four quarterly averages for each year, although the difference is not statistically significant. The number of benzo(a)pyrene concentrations greater than 0.1 ng/m^3 is highest for the first quarter for each year. Twelve benzo(a)pyrene concentrations greater than 0.1 ng/m^3 were measured at BNXY in 2016, compared to seven or fewer during each of the other calendar quarters. A similar observation can be made for 2015.

- The annual average and quarterly average concentrations of acenaphthene and fluorene are similar to each other. Concentrations of acenaphthene range from 0.688 ng/m^3 to 20.2 ng/m^3 and three non-detects while concentrations of fluorene range from 1.07 ng/m^3 to 20.5 ng/m^3 plus 13 non-detects. For both pollutants, the second and third quarter average concentrations for 2015 are significantly higher than the first and fourth quarter averages, indicating that concentrations tended to be higher during the warmer months of the year. For 2016, the differences among the second, third, and fourth quarter averages is less pronounced.

Observations for ROCH from Table 17-3 include the following:

- Of the pollutants of interest for ROCH, naphthalene has the highest annual average concentrations, fluoranthene has the lowest, and the annual averages for acenaphthene and fluorene are similar to each other. The annual averages of naphthalene for ROCH are roughly half the magnitude of the annual averages for BXNY; conversely, the annual averages of acenaphthene and fluorene for ROCH are two to three times greater than the annual averages for BXNY.

- For 2015, the third quarter average concentration of naphthalene is significantly higher than each of the remaining quarterly average concentrations. Concentrations of naphthalene measured at ROCH in 2015 range from 13.9 ng/m^3 to 106 ng/m^3, with all four concentrations greater than 100 ng/m^3 measured in July, August, and September. Further, none of the 26 naphthalene concentrations less than 60 ng/m^3 were measured at ROCH during the third quarter. A similar observation can be made for 2016,

although the difference is not statistically significant, as there is more variability in the calendar quarters within which the "higher" naphthalene concentrations were measured.

- Quarterly average concentrations of acenaphthene, fluorene, and fluoranthene for the second and third quarters are significantly higher than the remaining quarterly average concentrations of each year, indicating that higher concentrations were measured during the warmer months of the year.

- Concentrations of acenaphthene span two orders of magnitude, ranging from 0.695 ng/m^3 to 61.4 ng/m^3 plus eight non-detects. All 47 acenaphthene concentrations greater than or equal to 15 ng/m^3 measured at ROCH were measured during the second or third quarters of either year. None of the eight non-detects were measured outside the first quarter of either year.

- Concentrations of fluorene measured at ROCH range from 0.877 ng/m^3 to 41.4 ng/m^3 plus 12 non-detects. All 35 fluorene concentrations greater than 20 ng/m^3 measured at ROCH were measured during the second or third quarters of the year. Only one of the 12 non-detects was measured outside the first or fourth quarter of either year.

- Concentrations of fluoranthene measured at ROCH range from 0.399 ng/m^3 to 24.2 ng/m^3. All 44 fluoranthene concentrations greater than 5 ng/m^3 measured at ROCH were measured during the second or third quarters of either year. Further, none of the 17 fluoranthene concentrations less than 1 ng/m^3 were measured outside the first or fourth quarters of either year.

Tables 4-10 through 4-13 present the NMP sites with the 10 highest annual average concentrations for each of the program-level pollutants of interest. Observations for BXNY and ROCH from those tables include the following:

- BXNY has the second (2015) and fourth (2016) highest annual average concentrations of naphthalene among NMP sites sampling PAHs, as shown in Table 4-12. BXNY is one of only two NMP sites with an annual average naphthalene concentration greater than 100 ng/m^3. ROCH does not appear in Table 4-12 for naphthalene.

- ROCH's annual average concentrations of acenaphthene and fluorene both rank third (2015) and fourth (2016) highest among NMP sites sampling PAHs. BXNY does not appear in Table 4-12 for its annual average concentrations of acenaphthene. BXNY's annual average fluorene concentration for 2016 ranks ninth while this site's annual average for 2015 does not appear in Table 4-12 (it ranks 11th).

17.3.2 Concentration Comparison

In order to better illustrate how each site's annual average concentrations compare to the program-level averages, a site-specific box plot was created for each of the site-specific pollutants of interest, where applicable. Thus, box plots were created for the pollutants listed in Table 17-3 for BXNY and ROCH. Figures 17-5 through 17-9 overlay the site's minimum, annual average, and maximum concentrations for each year onto the program-level minimum, first quartile, median, average, third quartile, and maximum concentrations for each pollutant, as described in Section 3.4.2.1, and are discussed below. If an annual average concentration could not be calculated, the range of concentrations are still provided in the figures that follow.

Figure 17-5. Program vs. Site-Specific Average Acenaphthene Concentrations

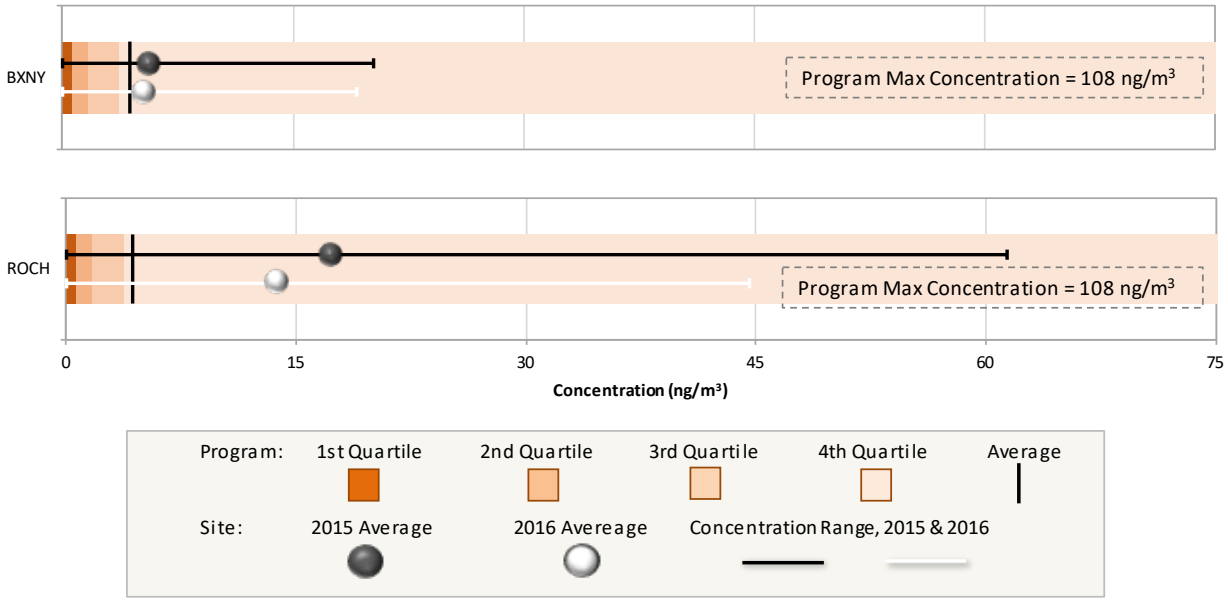


Figure 17-5 presents the box plots for acenaphthene for BXNY and ROCH and shows the following:

- The program-level maximum concentration (108 ng/m^3) is not shown directly on the box plots because the scale of the box plots would be too large to readily observe data points at the lower end of the concentration range. Thus, the scale has been reduced.

- The maximum acenaphthene concentration measured at ROCH is about three times greater than the maximum concentration measured at BXNY. Although the highest concentration measured at ROCH is half the magnitude of the maximum acenaphthene concentration measured across the program, it is the ninth highest concentration measured across the program.

- The annual average concentrations for BXNY are similar to each other, and just greater than the program-level average concentration (4.36 ng/m^3), while the annual averages for ROCH are three (2016) and four (2015) times greater the program-level average concentration.

- ROCH has the third (2015) and fourth (2016) highest annual average concentrations of acenaphthene among NMP sites sampling PAHs (behind only NBIL).

Figure 17-6. Program vs. Site-Specific Average Benzo(a)pyrene Concentrations

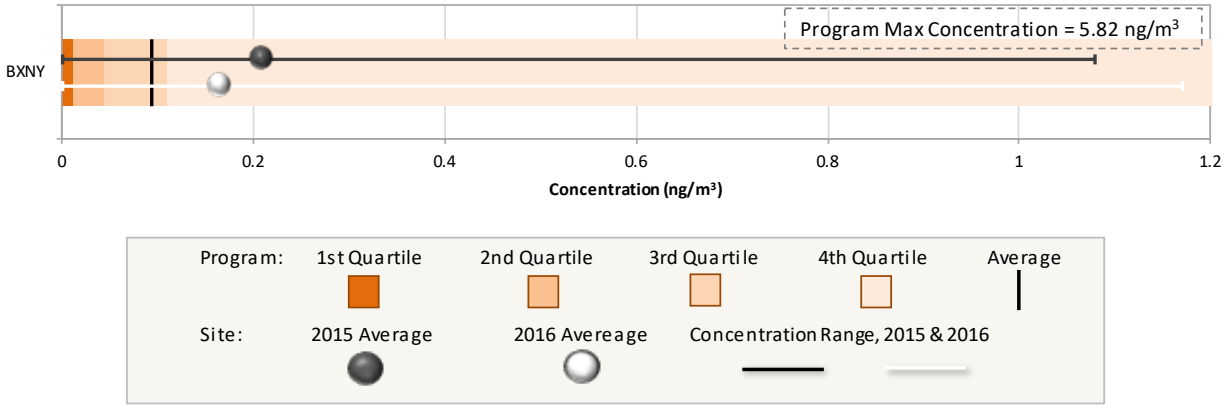


Figure 17-6 presents the box plot for benzo(a)pyrene for BXNY and shows the following:

- The program-level maximum concentration (5.82 ng/m^3) is not shown directly on the box plot because the scale of the box plot would be too large to readily observe data points at the lower end of the concentration range. Thus, the scale has also been reduced.

- BXNY is one of only two sites for which benzo(a)pyrene is a pollutant of interest (UNVT is the other).

- The maximum benzo(a)pyrene concentration measured at BXNY is not the maximum concentration measured across the program, although it is the among the highest measured. (The maximum benzo(a)pyrene concentration measured across the program was actually measured at ROCH, although benzo(a)pyrene was not identified as a pollutant of interest for ROCH).

- The annual average concentrations of benzo(a)pyrene for BXNY are both greater than the program-level average concentration (0.09 ng/m^3), with BXNY's annual average for 2015 more than twice the magnitude.

Figure 17-7. Program vs. Site-Specific Average Fluoranthene Concentrations

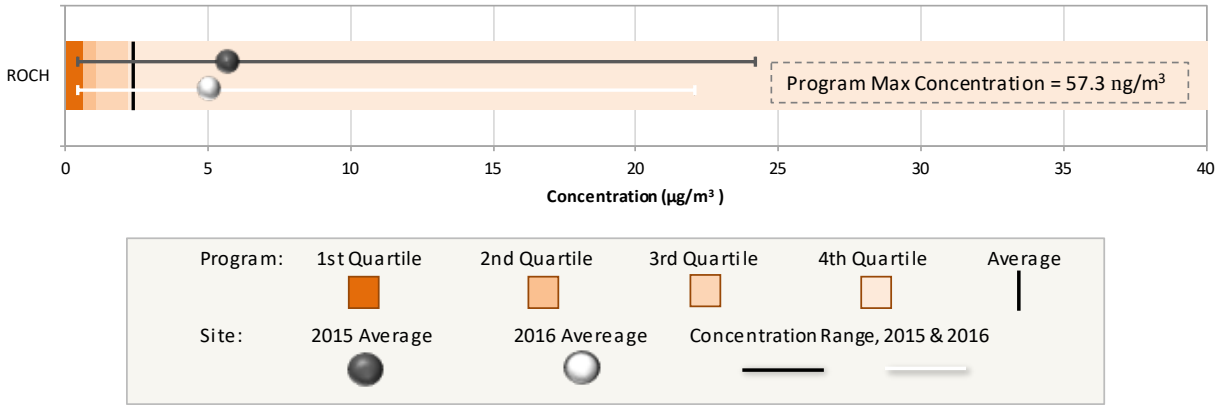


Figure 17-7 presents the box plot for fluoranthene for ROCH and shows the following:

- The program-level maximum concentration (57.3 ng/m^3) is not shown directly on the box plot because the scale of the box plot would be too large to readily observe data points at the lower end of the concentration range. Thus, the scale of this box plot has also been reduced.

- ROCH is one of only three NMP sites for which fluoranthene is a pollutant of interest (NBIL and GPCO are the others).

- The maximum fluoranthene concentration measured at ROCH is considerably less than the maximum concentration measured across the program, although few NMP sites have measurements greater than ROCH's maximum fluoranthene concentrations.

- Both annual average concentrations for ROCH are more than twice the program-level average concentration (2.39 ng/m^3). Only one NMP site each year has an annual average concentration greater than ROCH's (NBIL).

Figure 17-8. Program vs. Site-Specific Average Fluorene Concentrations

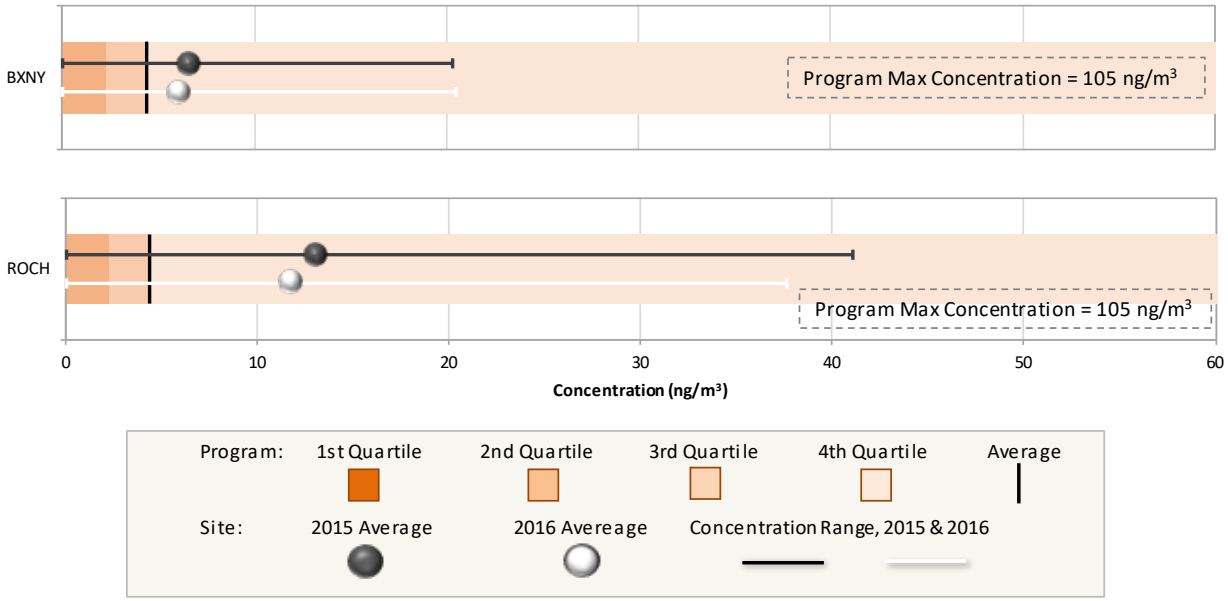


Figure 17-8 presents the box plots for fluorene for BXNY and ROCH and shows the following:

- The program-level maximum concentration (105 ng/m^3) is not shown directly on the box plots because the scale of the box plots would be too large to readily observe data points at the lower end of the concentration range. Thus, the scale has been reduced. The program-level first quartile is zero for this pollutant, indicating that at least 25 percent of the measurements across the program are non-detects and thus, are not visible on the box plot.

- The maximum fluorene concentration measured at ROCH is more than two times greater than the maximum concentration measured at BXNY, although both sites' maximum concentrations are considerably less than the highest concentration measured across the program.

- The annual average concentrations for ROCH are roughly twice the annual averages for BXNY, although both sites' annual averages are greater than the program-level average concentration (4.36 ng/m^3).

- ROCH has the third (2015) and fourth (2016) highest annual average concentrations of fluorene among NMP sites sampling PAHs (behind only NBIL).

Figure 17-9. Program vs. Site-Specific Average Naphthalene Concentrations

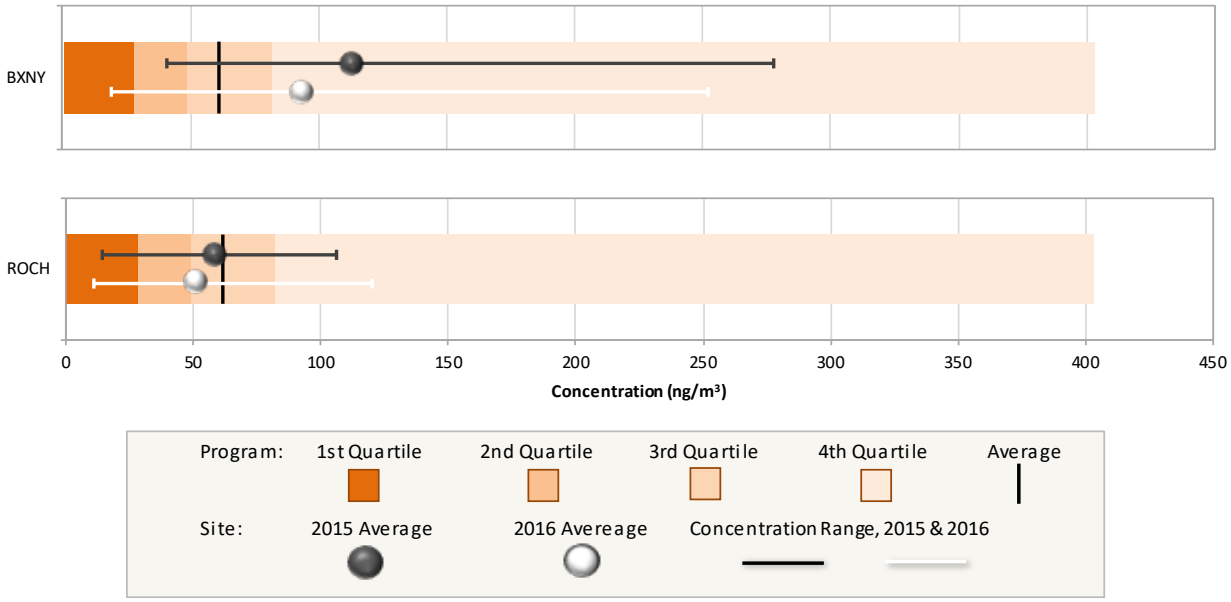


Figure 17-9 presents the box plots for naphthalene for BXNY and ROCH and shows the following:

- In contrast to the box plots for the other pollutants of interest in common for the New York sites, Figure 17-9 shows that the maximum naphthalene concentrations measured at BXNY are considerably greater than those measured at ROCH.

- The minimum naphthalene concentrations measured each year at ROCH are fairly similar to each other while the minimum concentrations measured at BXNY are considerably different. The minimum concentration measured at BXNY in 2015 is more than twice the minimum concentration measured in 2016. The five lowest naphthalene concentrations measured at BXNY were measured in 2016. The minimum concentration measured at BXNY in 2015 is higher than the program-level first quartile and the highest minimum concentration measured among NMP sites sampling naphthalene in 2015. A similar observation was made in the 2013 and 2014 NMP reports.

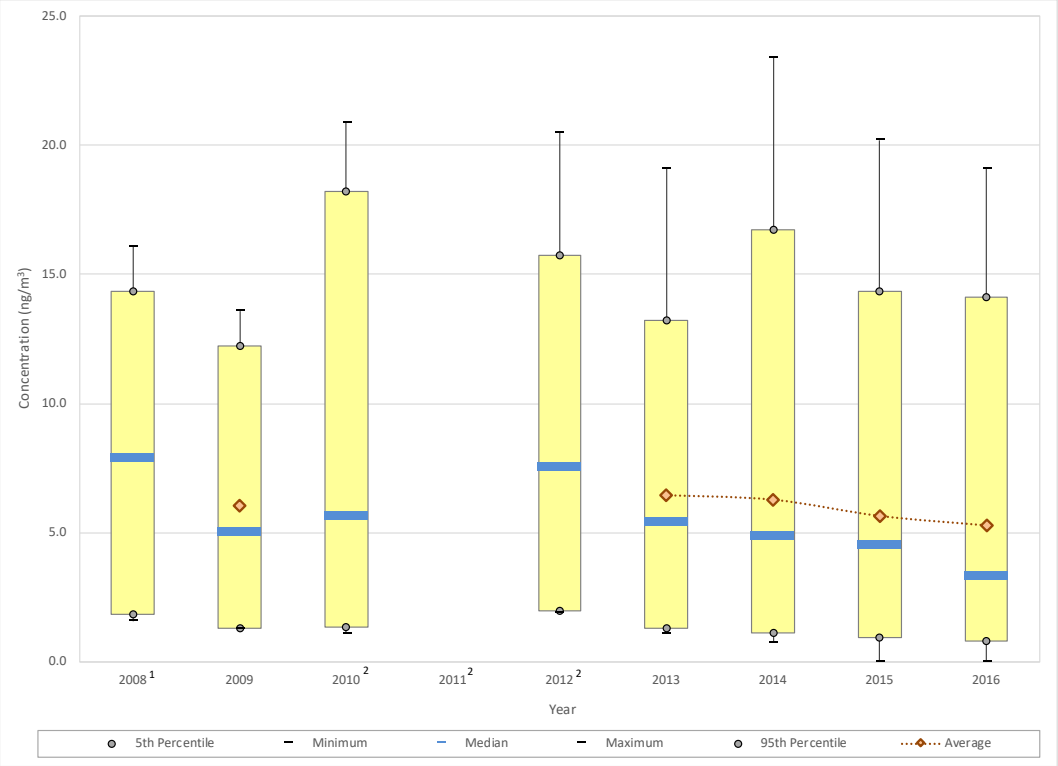
- The annual average naphthalene concentrations for ROCH fall between the program-level median concentration (48.90 ng/m^3) and the program-level average (61.23 ng/m^3) concentration. The annual average concentrations for BXNY roughly twice the magnitude of ROCH's annual averages, and are greater than the program-level average and third quartile. BXNY has the second (2015) and fourth (2016) highest annual average concentrations of naphthalene among NMP sites sampling PAHs.

17.3.3 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the pollutants of interest for 5 consecutive years or longer, as described in Section 3.4.2.2. Sampling for PAHs at BXNY began in July 2008. However, in June 2010, the instrumentation at BXNY was relocated to a new, temporary location due to roofing construction near the BXNY site. Two years later, the instrumentation was returned to the BXNY site and sampling resumed at this location in July 2012. The trends analysis was performed for BXNY but does not include data from the temporary location. Figures 17-10 through 17-13 present the 1-year statistical metrics for the pollutants of interest for BXNY.

Sampling for PAHs at ROCH also began in July 2008. However, a collection error was discovered at the site, resulting in the invalidation of nearly one and one-half years' worth of samples between July 2009 and December 2010. Thus, a 1-year average concentration for 2009 is not provided on the trends graph and no statistical metrics are provided for 2010. This, combined with the mid-year start in 2008, results in the calculation of few 1-year average concentrations for the ROCH monitoring site during the early years of sampling. Figure 17-14 through 17-17 present the 1-year statistical metrics for the pollutants of interest for ROCH.

Figure 17-10. Yearly Statistical Metrics for Acenaphthene Concentrations Measured at BXNY



[1] A 1-year average is not presented because sampling under the NMP did not begin until July 2008.
[2] Some statistical metrics are not presented due to temporary site relocation from June 2010-July 2012.

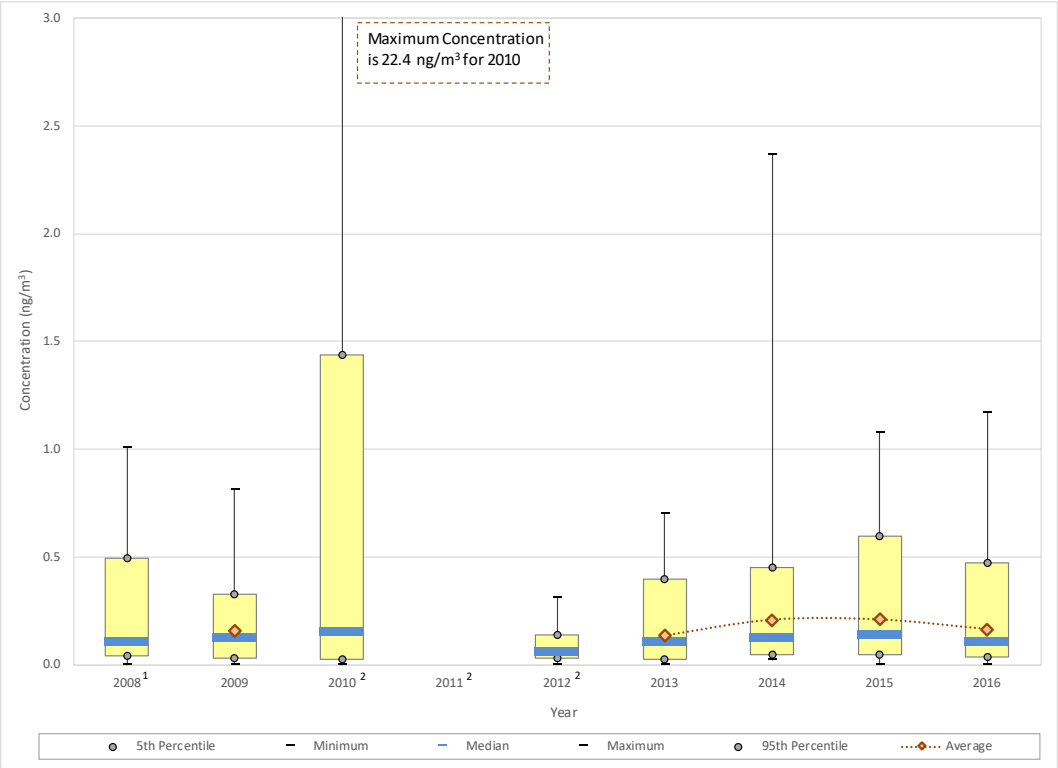
Observations from Figure 17-10 for acenaphthene concentrations measured at BXNY include the following:

- The maximum acenaphthene concentration was measured at BXNY in 2014 (23.4 ng/m^3), although concentrations greater than 20 ng/m^3 were also measured in 2010, 2012, and 2015.

- Prior to 2013, there is only one year (2009) with a full year's worth of samples for BXNY. With the exception of the maximum concentration, the concentration profile for 2009 resembles the concentration profile for 2013.

- Several of the statistical parameters exhibit decreases over the last several years of sampling, with several of the statistical parameters at a minimum for 2016. The median concentration decreased each year between 2012 and 2016, decreasing by more than half during this period, from 7.52 ng/m^3 (2012) to 3.32 ng/m^3 (2016). The first non-detects were measured in 2015 and 2016. The 1-year average concentration decreased slightly each year between 2013 and 2016, although the confidence intervals indicate the difference is not statistically significant as there is considerable variability in the measurements.

Figure 17-11. Yearly Statistical Metrics for Benzo(a)pyrene Concentrations Measured at BXNY



[1] A 1-year average is not presented because sampling under the NMP did not begin until July 2008.
[2] Some statistical metrics are not presented due to temporary site relocation from June 2010-July 2012.

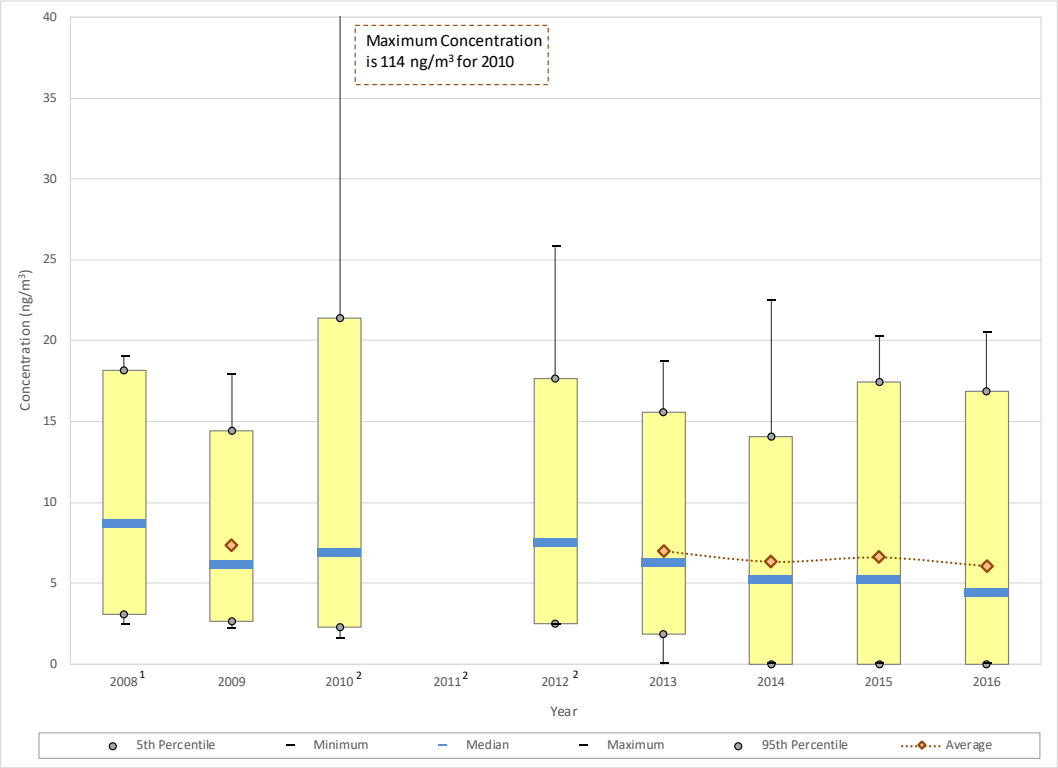
Observations from Figure 17-11 for benzo(a)pyrene concentrations measured at BXNY include the following:

- The maximum benzo(a)pyrene concentration was measured at BXNY in 2010 (22.4 ng/m^3) and is an order of magnitude greater than the next highest benzo(a)pyrene concentration measured at this site (2.37 ng/m^3), which was measured in 2014. No other concentrations greater than 2 ng/m^3 have been measured at BXNY.

- Prior to 2013, there is only one year (2009) with a full year's worth of samples for BXNY. If the outlier measured in 2010 was excluded from the dataset, the concentration profile for 2010 would have the second widest range of measurements (behind 2014), the largest difference between its 5th and 95th percentiles, and the highest median concentration. By contrast, nearly all of the statistical parameters are at a minimum for 2012.

- The median benzo(a)pyrene concentration varies by less than 0.05 ng/m^3 over the last several years of sampling, ranging from 0.10 ng/m^3 (2013) to 0.14 ng/m^3 (2015). The 1-year average concentration varies slightly more, though the differences are not statistically significant.

Figure 17-12. Yearly Statistical Metrics for Fluorene Concentrations Measured at BXNY



[1] A 1-year average is not presented because sampling under the NMP did not begin until July 2008.
[2] Some statistical metrics are not presented due to temporary site relocation from June 2010-July 2012.

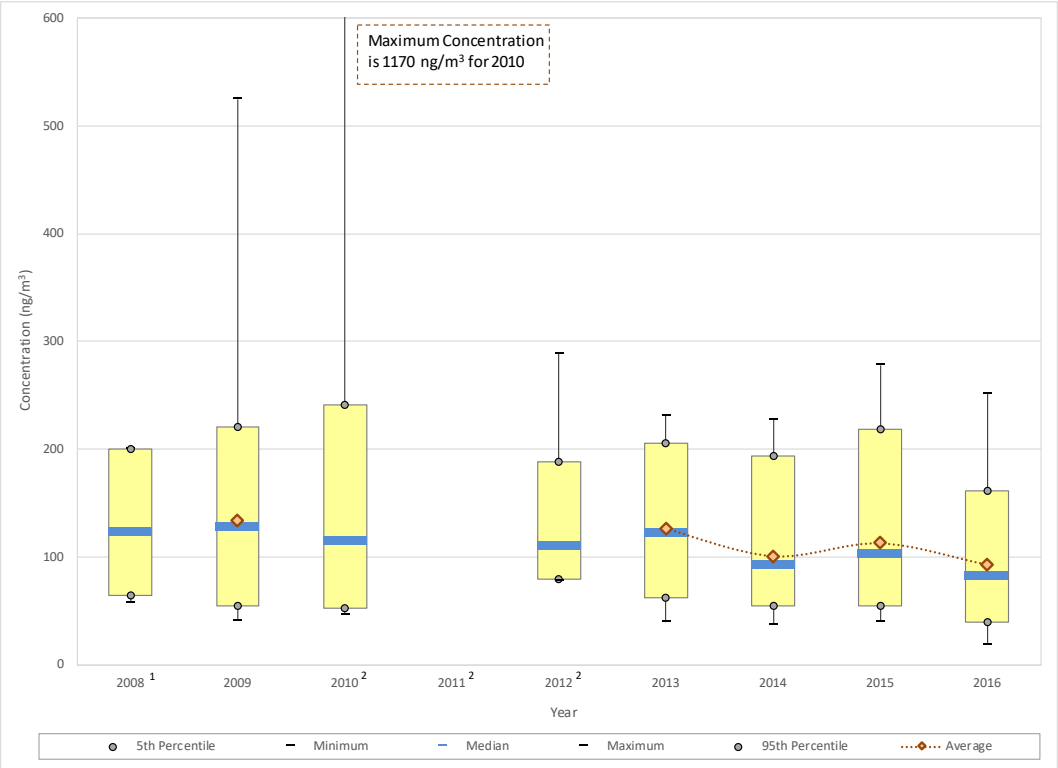
Observations from Figure 17-12 for fluorene concentrations measured at BXNY include the following:

- The maximum fluorene concentration (114 ng/m^3) was measured on the same day the maximum benzo(a)pyrene concentration was measured (January 14, 2010).

- Non-detects of fluorene were not measured until 2013. The number of non-detects measured has increased each year since, from three in 2013 to 12 in 2016.

- The median fluorene concentration decreased by more than 1 ng/m^3 from 2012 to 2013 and again for 2014. Little change is shown for 2015, before additional decreases are shown for 2016. During this time, the median concentration decreased from 7.49 ng/m^3 for 2012 to 4.44 ng/m^3 for 2016. The 1-year average concentration varies by less than 1 ng/m^3 during this period, ranging from 7.01 ng/m^3 for 2013 to 6.06 ng/m^3 for 2016.

Figure 17-13. Yearly Statistical Metrics for Naphthalene Concentrations Measured at BXNY



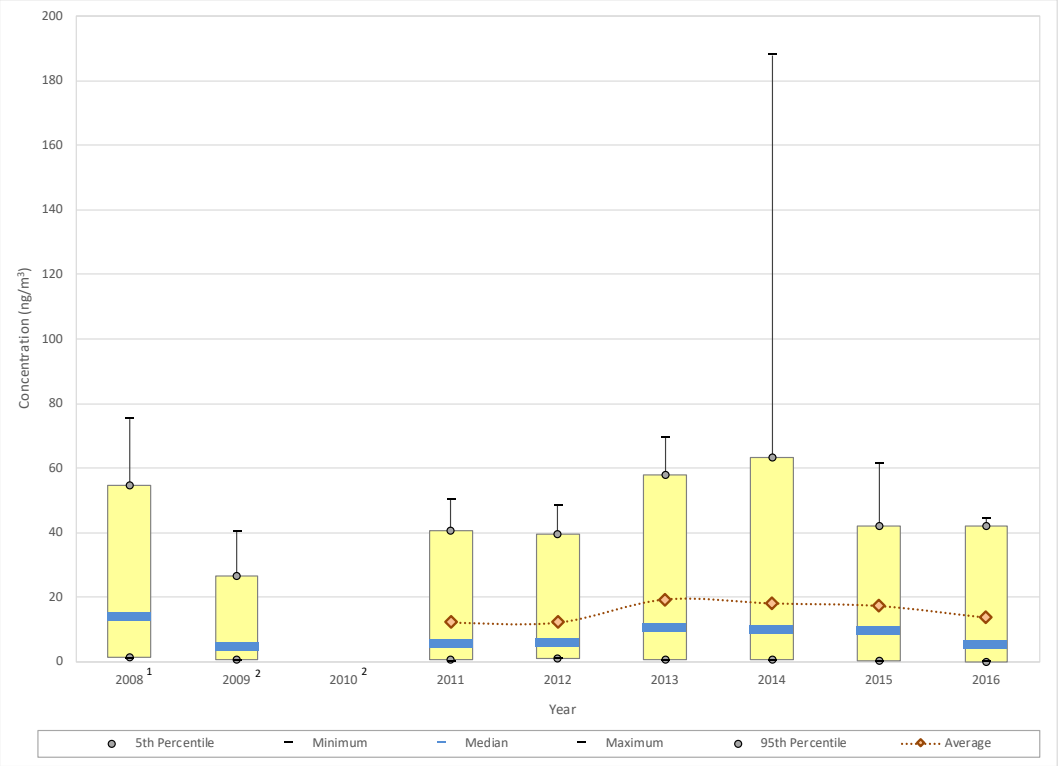
[1] A 1-year average is not presented because sampling under the NMP did not begin until July 2008.
[2] Some statistical metrics are not presented due to temporary site relocation from June 2010-July 2012.

Observations from Figure 17-13 for naphthalene concentrations measured at BXNY include the following:

- The maximum naphthalene concentration (1,170 ng/m^3) was measured on the same day the maximum benzo(a)pyrene and fluorene concentrations were measured (January 14, 2010). The next highest concentration, measured in 2009, was nearly half as high (525 ng/m^3). No additional naphthalene concentrations greater than 300 ng/m^3 have been measured at BXNY.

- The central tendency parameters have an undulating pattern between 2013 and 2016. With the exception of the maximum concentration, each of the statistical parameters is at a minimum for 2016. Both the 1-year average and median concentrations are less than 100 ng/m^3 for the first time.

Figure 17-14. Yearly Statistical Metrics for Acenaphthene Concentrations Measured at ROCH



[1] A 1-year average is not presented because sampling under the NMP did not begin until July 2008.
[2] Some statistical metrics are not presented because data from July 2009 to Dec 2010 was invalidated.

Observations from Figure 17-14 for acenaphthene concentrations measured at ROCH include the following:

- The range of acenaphthene concentrations appears to have decreased by half from 2008 to 2009, although 2008 includes data from July through December while 2009 includes data from January through June.

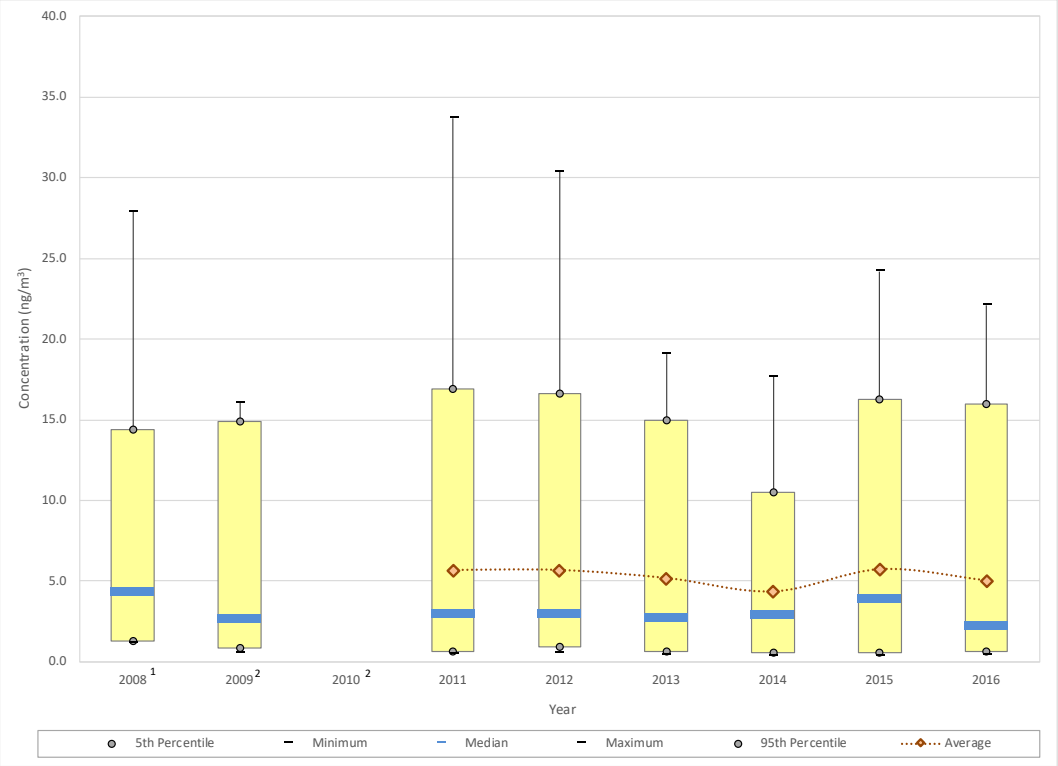
- The concentrations measured in 2011 are similar to the concentrations measured in 2012.

- The range of concentrations measured increased from 2012 to 2013. The median concentration nearly doubled from 2012 to 2013 while the 1-year average concentration increased by 58 percent.

- The maximum concentration increased considerably for 2014, with three acenaphthene concentrations measured in 2014 that are greater than the maximum concentration measured in 2013. Despite these higher measurements, the 1-year average and median concentrations decreased slightly.

- Nearly all of the statistical parameters exhibit decreases for 2015 and 2016. The only non-detects measured at ROCH were measured in 2015 (3) and 2016 (5).

Figure 17-15. Yearly Statistical Metrics for Fluoranthene Concentrations Measured at ROCH



[1] A 1-year average is not presented because sampling under the NMP did not begin until July 2008.
[2] Some statistical metrics are not presented because data from July 2009 to Dec 2010 was invalidated.

Observations from Figure 17-15 for fluoranthene concentrations measured at ROCH include the following:

- Two fluoranthene concentrations greater than 30 ng/m^3 have been measured at ROCH, one in 2011 (33.7 ng/m^3) and one in 2012 (30.4 ng/m^3).

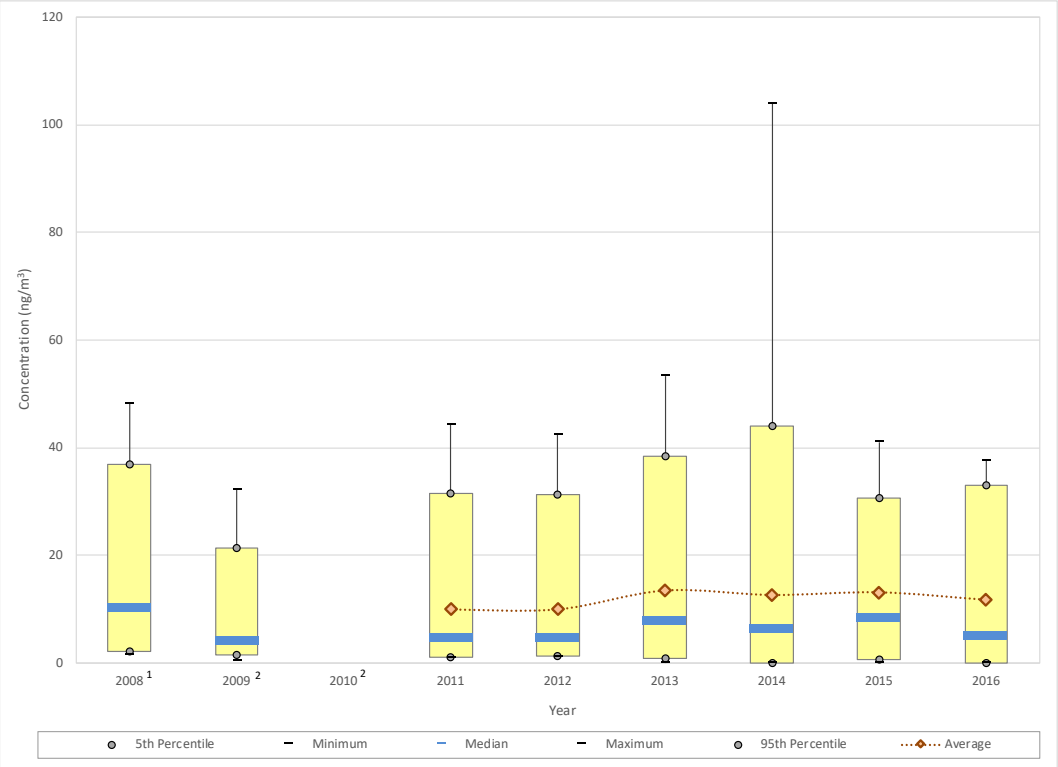
- The range of fluoranthene concentrations measured decreased each year between 2011 and 2014, when several of the statistical parameters, including the 1-year average concentration, were at a minimum.

- With the exception of the minimum concentration, each of the statistical parameters exhibits an increase for 2015. In addition to a few "higher" concentrations, the number of fluoranthene concentrations greater than 10 ng/m^3 tripled, increasing from four measured in 2014 to 13 measured in 2015.

- Although the range of concentrations measured in 2015 is not much different than the range measured in 2016, the central tendency parameters decreased, and the median concentration is at a minimum for the period of sampling. The number of fluoranthene concentrations less than 2 ng/m^3 is at its highest in 2016, accounting for nearly half of the measurements.

- Excluding 2014, each of the 1-year average concentrations falls between 5 ng/m^3 and 6 ng/m^3.

Figure 17-16. Yearly Statistical Metrics for Fluorene Concentrations Measured at ROCH



[1] A 1-year average is not presented because sampling under the NMP did not begin until July 2008.
[2] Some statistical metrics are not presented because data from July 2009 to Dec 2010 was invalidated.

Observations from Figure 17-16 for fluorene concentrations measured at ROCH include the following:

- The concentration profiles for fluorene resemble the concentration profiles for acenaphthene.

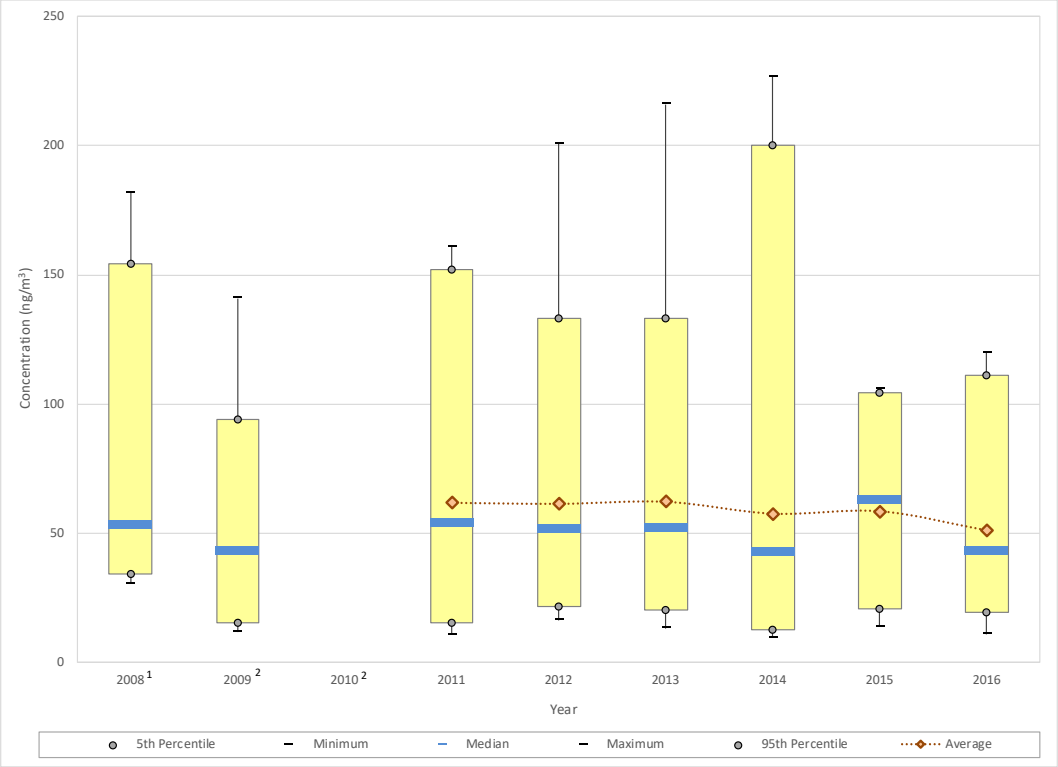
- The range of fluorene concentrations measured at ROCH decreased from 2008 to 2009, with the median concentration decreasing by more than half during this time. However, each year's concentration profile includes half a year's worth of samples (2008 includes data from July through December and 2009 includes data from January through June).

- The concentrations measured in 2011 are similar to the concentrations measured in 2012.

- Both central tendency parameters exhibit increases for 2013, as the range of measurements increased from 2012 to 2013 (at both ends of the concentration range). The median increased by 67 percent from 2012 to 2013 while the 1-year average concentration increased by 35 percent.

- Relatively little change in the 1-year average concentration is shown between 2013 and 2016, despite variations in the concentrations measured. The maximum concentration of fluorene measured at ROCH was measured in 2014 (104 ng/m^3). Two additional concentrations greater than 50 ng/m^3 have been measured at this site, one in 2013 (53.4 ng/m^3) and another in 2014 (51.4 ng/m^3). Despite the higher concentrations measured, only slight changes are shown in both the 1-year average and median concentrations. This is due primarily to the increase in non-detects measured in 2014 (seven). The first non-detects were measured at ROCH in 2013 (two), with several measured each year thereafter. The number of non-detects is at a maximum of nine for 2016.

Figure 17-17. Yearly Statistical Metrics for Naphthalene Concentrations Measured at ROCH



[1] A 1-year average is not presented because sampling under the NMP did not begin until July 2008.
[2] Some statistical metrics are not presented because data from July 2009 to Dec 2010 was invalidated.

Observations from Figure 17-17 for naphthalene concentrations measured at ROCH include the following:

- Similar to the other pollutants of interest, the range of naphthalene concentrations decreased from 2008 to 2009. However, each year's concentration profile includes half a year's worth of samples.

- Even though the maximum concentration increased each year between 2011 and 2013, the 1-year average naphthalene concentrations calculated for 2011, 2012, and 2013 exhibit little change, varying by less than 1 ng/m^3 across these years. The range of naphthalene concentrations measured at ROCH expanded further in 2014, though the 1-year average for 2014 decreased slightly. This is also true for the median concentration. Several of the lowest naphthalene concentrations were measured in 2014, including the most concentrations less than 20 ng/m^3 (seven) since the onset of sampling.

- The range of naphthalene concentrations measured decreased considerably in 2015. Yet, the 1-year average changed little and the median increased by nearly 50 percent and is greater than the 1-year average concentration. This results from an increase in the number of measurements in the mid- to upper-half of the concentration range. The number of naphthalene concentrations between 50 ng/m^3 and 100 ng/m^3 increased from 12 in 2014 to 30 for 2015.

- Although the range of concentrations measured in 2016 is only slightly larger than the range measured in 2015, both central tendency parameters exhibit decreases, with the 1-year average concentration at a minimum for 2016. A higher number of naphthalene concentrations at the lower end of the concentration range were measured in 2016; the number of concentrations less than 25 ng/m^3 increased from seven measured in 2015 to 16 in 2016.

17.4 Additional Risk-Based Screening Evaluations

The following risk-based screening evaluations were conducted to characterize risk related to the air toxics measured at the New York monitoring sites. Refer to Sections 3.2, 3.4.2.3, and 3.4.2.4 for definitions and explanations regarding the various toxicity factors, time frames, and calculations associated with these risk-based screenings.

17.4.1 Cancer Risk and Noncancer Hazard Approximations

For the pollutants of interest for the New York sites, risk was examined by calculating cancer risk and noncancer hazard approximations for each year annual average concentrations could be calculated. These approximations can be used as risk estimates for cancer and noncancer effects attributable to the pollutants of interest. Although the use of these approximations is limited, they may help identify where policy-makers want to shift their air monitoring priorities. Refer to Section 3.4.2.3 for an explanation of how cancer risk and noncancer hazard approximations are calculated and what limitations are associated with them. Annual averages, cancer UREs and/or noncancer RfCs, and cancer risk and noncancer hazard approximations are presented in Table 17-4, where applicable. Cancer risk approximations are presented as probabilities while the noncancer hazard approximations are ratios and thus, unitless values.

Observations for the New York sites from Table 17-4 include the following:

- Naphthalene has the highest annual average concentrations among the pollutants of interest for each site.

- Naphthalene has the highest cancer risk approximations for BXNY (both greater than 3 in-a-million). The cancer risk approximations for the other pollutants of interest for BXNY are less than 1 in-a-million.

- For ROCH, naphthalene also has the highest cancer risk approximations, though the difference among the cancer risk approximations among ROCH's pollutants of interest is considerably less (three of the four pollutants have cancer risk approximations between 1 in-a-million and 2 in-a-million).

- Naphthalene is the only site-specific pollutant of interest for either site that has a noncancer RfC. The noncancer hazard approximations for naphthalene for each site are less than 0.05, considerably less than 1.0, indicating that no adverse noncancer health effects are expected from this individual pollutant.

Table 17-4. Risk Approximations for the New York Monitoring Sites

Pollutant	Cancer URE ($\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	2015				2016			
			# of Measured Detections vs. # of Samples	Annual Average (ng/m^3)	Risk Approximations		# of Measured Detections vs. # of Samples	Annual Average (ng/m^3)	Risk Approximations	
					Cancer (in-a-million)	Noncancer (HQ)			Cancer (in-a-million)	Noncancer (HQ)
Bronx, New York - BXNY										
Acenaphthene	0.000088	--	57/59	5.65 ± 1.12	0.50	--	60/61	5.28 ± 1.14	0.46	--
Benzo(a)pyrene	0.00176	--	57/59	0.21 ± 0.05	0.37	--	60/61	0.17 ± 0.05	0.29	--
Fluorene	0.000088	--	53/59	6.61 ± 1.30	0.58	--	49/61	6.06 ± 1.41	0.53	--
Naphthalene	0.000034	0.003	59/59	113.05 ± 12.40	3.84	0.04	61/61	93.29 ± 10.96	3.17	0.03
Rochester, New York - ROCH										
Acenaphthene	0.000088	--	53/56	17.37 ± 4.25	1.53	--	55/60	13.81 ± 3.80	1.22	--
Fluoranthene	0.000088	--	56/56	5.73 ± 1.51	0.50	--	60/60	5.03 ± 1.39	0.44	--
Fluorene	0.000088	--	53/56	13.07 ± 3.08	1.15	--	51/60	11.71 ± 3.14	1.03	--
Naphthalene	0.000034	0.003	56/56	58.54 ± 7.04	1.99	0.02	60/60	51.02 ± 7.73	1.73	0.02

-- = A Cancer URE or Noncancer RfC is not available.

17.4.2 Risk-Based Emissions Assessment

In addition to the risk-based screening discussed above, this section presents an evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 17-5 presents the 10 pollutants with the highest emissions from the 2014 NEI (version 1) that have cancer toxicity factors. Table 17-5 also presents the 10 pollutants with the highest toxicity-weighted emissions, based on the weighting schema described in Section 3.4.2.4. Lastly, Table 17-5 provides the pollutants of interest with the highest cancer risk approximations (in-a-million) for each site, as presented in Table 17-4. Cancer risk approximations for 2015 are presented in green while approximations for 2016 are in white. The emissions, toxicity-weighted emissions, and cancer risk approximations are shown in descending order in Table 17-5. Table 17-6 presents similar information, but is limited to those pollutants with noncancer toxicity factors.

Because not all pollutants have both cancer and noncancer toxicity factors, the highest emitted pollutants in the cancer table may be different from the noncancer table, although the actual quantity of emissions is the same. The cancer risk and noncancer hazard approximations based on each site's annual averages are limited to the pollutants of interest identified for each site. In addition, the cancer risk and noncancer hazard approximations are limited to those pollutants with enough data to meet the criteria for annual averages to be calculated. A more in-depth discussion of this analysis is provided in Section 3.4.2.4. Similar to the cancer risk and noncancer hazard approximations provided in Section 17.4.1, this analysis may help policy-makers prioritize their air monitoring activities.

Table 17-5. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the New York Monitoring Sites

Top 10 Total Emissions for Pollutants with Cancer UREs (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Bronx, New York (Bronx County) - BXNY					
Benzene	140.01	Formaldehyde	1.73E-03	Naphthalene	3.84
Formaldehyde	133.13	Benzene	1.09E-03	Naphthalene	3.17
Dichloromethane	112.31	1,3-Butadiene	5.93E-04	Fluorene	0.58
Ethylbenzene	76.18	Naphthalene	5.87E-04	Fluorene	0.53
Acetaldehyde	68.23	POM, Group 2b	2.52E-04	Acenaphthene	0.50
1,3-Butadiene	19.77	POM, Group 2d	2.45E-04	Acenaphthene	0.46
Naphthalene	17.28	Ethylene oxide	2.29E-04	Benzo(a)pyrene	0.37
Tetrachloroethylene	15.79	Arsenic, PM	1.95E-04	Benzo(a)pyrene	0.29
1,4-Dioxane	15.39	Ethylbenzene	1.90E-04		
POM, Group 2b	2.86	POM, Group 5a	1.62E-04		
Rochester, New York (Monroe County) - ROCH					
p-Dichlorobenzene	314.57	*p*-Dichlorobenzene	3.46E-03	Naphthalene	1.99
Benzene	223.73	Formaldehyde	2.34E-03	Naphthalene	1.73
Formaldehyde	180.29	Benzene	1.75E-03	Acenaphthene	1.53
Ethylbenzene	106.86	1,3-Butadiene	1.08E-03	Acenaphthene	1.22
Acetaldehyde	102.79	Naphthalene	8.00E-04	Fluorene	1.15
Tetrachloroethylene	81.75	Arsenic, PM	4.41E-04	Fluorene	1.03
1,3-Dichloropropene	80.40	POM, Group 2b	4.27E-04	Fluoranthene	0.50
1,3-Butadiene	35.96	POM, Group 2d	3.35E-04	Fluoranthene	0.44
Naphthalene	23.52	1,3-Dichloropropene	3.22E-04		
Dichloromethane	12.92	POM, Group 5a	3.20E-04		

[1] Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Table 17-6. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the New York Monitoring Sites

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific) [1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Hazard Approximation (HQ)**
Bronx, New York (Bronx County) - BXNY					
Toluene	416.80	Acrolein	290,569.07	Naphthalene	0.04
Hexane	298.98	Acrylic acid	26,156.73	Naphthalene	0.03
Xylenes	243.02	Formaldehyde	13,585.10		
Benzene	140.01	1,3-Butadiene	9,883.64		
Formaldehyde	133.13	Acetaldehyde	7,581.21		
Dichloromethane	112.31	Naphthalene	5,758.99		
Ethylene glycol	77.61	Benzene	4,667.05		
Ethylbenzene	76.18	Cadmium, PM	4,020.53		
Acetaldehyde	68.23	Diethanolamine	3,889.87		
Isophorone	61.68	Triethylamine	3,671.84		
Rochester, New York (Monroe County) - ROCH					
Chlorobenzene	1,466.95	Acrolein	541,813.81	Naphthalene	0.02
Toluene	600.97	Chlorine	30,337.40	Naphthalene	0.02
Xylenes	539.99	Triethylamine	28,821.23		
p-Dichlorobenzene	314.57	Formaldehyde	18,396.73		
Hexane	306.97	1,3-Butadiene	17,979.41		
Hydrochloric acid	260.76	Hydrochloric acid	13,038.15		
Benzene	223.73	Acetaldehyde	11,421.29		
Triethylamine	201.75	Cadmium, PM	9,670.45		
Formaldehyde	180.29	Naphthalene	7,840.69		
Methanol	129.75	Benzene	7,457.62		

[1] Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Observations from Table 17-5 include the following:

- Benzene, formaldehyde, and dichloromethane are the highest emitted pollutants with cancer UREs in Bronx County. *p*-Dichlorobenzene, benzene, and formaldehyde are the highest emitted pollutants in Monroe County.

- Formaldehyde, benzene, and 1,3-butadiene are the pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) for Bronx County. *p*-Dichlorobenzene, formaldehyde, and benzene are the pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) for Monroe County.

- Six of the highest emitted pollutants also have the highest toxicity-weighted emissions for Bronx County; six of the highest emitted pollutants also have the highest toxicity-weighted emissions for Monroe County.

- Naphthalene, which is a pollutant of interest for both sites and has the highest cancer risk approximations for each site, appears on both emissions-based lists for Bronx and Monroe Counties.

- Emissions of several POM Groups rank among the pollutants with the highest toxicity-weighted emissions for Bronx County. POM, Group 2b appears on both emissions-based lists for Bronx County and includes several PAHs sampled for at BXNY, including acenaphthene, fluoranthene, and fluorene. POM, Group 5a also appears among those with the highest toxicity-weighted emissions for Bronx County; this group includes benzo(a)pyrene, which is also a pollutant of interest for BXNY. POM, Group 2d also appears among those with the highest toxicity-weighted emissions for Bronx County, although none of the PAHs sampled with Method TO-13A are included in this group. POM, Groups 2b, 2d, and 5a also appear among the pollutants with the highest toxicity-weighted emissions for Monroe County, although none appear among the highest emitted pollutants for Monroe County.

Observations from Table 17-6 include the following:

- Toluene, hexane, and xylenes are the highest emitted pollutants with noncancer RfCs in Bronx County. Chlorobenzene is the highest emitted pollutant with a noncancer RfC in Monroe County, followed by toluene and xylenes.

- The pollutant with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) is acrolein for both counties.

- Three of the highest emitted pollutants in Bronx County are also among the pollutants with the highest toxicity-weighted emissions; four of the highest emitted pollutants in Monroe County are also among the pollutants with the highest toxicity-weighted emissions.

- Naphthalene is the only pollutant of interest for each site for which a noncancer RfC is available, and thus noncancer hazard approximations could be calculated. Naphthalene is among the pollutants with the highest toxicity-weighted emissions for each county, but is not among the highest emitted pollutants with a noncancer toxicity factor for either county.

17.5 Summary of the 2015-2016 Monitoring Data for BXNY and ROCH

Results from several of the data analyses described in this section include the following:

- *Six PAHs failed screens for BXNY, of which four were identified as pollutants of interest. Eight PAHs failed screens for ROCH, of which four were identified as pollutants of interest. Naphthalene, acenaphthene, and fluorene were identified as pollutants of interest for both New York monitoring sites.*

- *Naphthalene has the highest annual average concentrations for both sites, although the annual averages for BXNY are nearly twice the annual averages for ROCH.*

- *BXNY has some of the highest annual average concentrations of naphthalene among NMP sites sampling PAHs. ROCH has some of the highest annual average concentrations of acenaphthene and fluorene among NMP sites sampling PAHs.*

- *For both BXNY and ROCH, the 1-year average concentrations of naphthalene for 2016 are at a minimum over the course of sampling.*

- *Naphthalene has the highest cancer risk approximations among the pollutants of interest for both BXNY and ROCH (although the differences among the pollutants of interest for ROCH is relatively small). None of the pollutants of interest have noncancer hazard approximations greater than an HQ of 1.0.*

18.0 Sites in Oklahoma

This section summarizes those data from samples collected at the UATMP sites in Oklahoma and generated by ERG, EPA's contract laboratory for the NMP, over the 2015 and 2016 monitoring efforts. This section also examines the spatial and temporal characteristics of the ambient monitoring concentrations and reviews them through the context of risk. Readers are encouraged to refer to Sections 1 through 4 for detailed discussions and definitions regarding the various data analyses presented below.

> Data generated by sources other than ERG, EPA's contract laboratory for the NMP, are not included in the data analyses contained in this report.

18.1 Site Characterization

This section characterizes the Oklahoma monitoring sites by providing a description of the nearby area surrounding each monitoring site; plotting emissions sources surrounding the monitoring sites; and presenting traffic data and other characterizing information for each site. This information is provided to give the reader insight regarding factors that may influence the air quality near the sites and assist in the interpretation of the ambient measurements.

Seven monitoring sites are located in Oklahoma. Three sites (TOOK, TMOK, and TROK) are located in Tulsa. Two additional monitoring sites are located in Oklahoma City (OCOK and NROK), with another located in Yukon, just west of Oklahoma City (YUOK). The final site (BROK) is located in the town of Bradley, 42 miles south-southwest of Oklahoma City. Figures 18-1 through 18-3 present composite satellite images retrieved from ArcGIS Explorer showing the Tulsa monitoring sites and their immediate surroundings. Figure 18-4 identifies nearby point source emissions locations by source category, as reported in the 2014 NEI for point sources, version 1. Note that only sources within 10 miles of the sites are included in the facility counts provided in Figure 18-4. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have a direct effect on the air quality at the monitoring sites. Further, this boundary provides both the proximity of emissions sources to the monitoring sites as well as the quantity of such sources within a given distance of the sites. Sources outside the 10-mile boundaries are still visible on the map for reference but have been grayed out to emphasize emissions sources within the boundaries. Figures 18-5 through 18-10 are the composite satellite maps and emissions sources maps for the remaining sites. Table 18-1 provides supplemental geographical information such as land use, location setting, and locational coordinates for each site. Each figure and table is discussed in detail in the paragraphs that follow.

Figure 18-1. Public Works, Tulsa, Oklahoma (TOOK) Monitoring Site

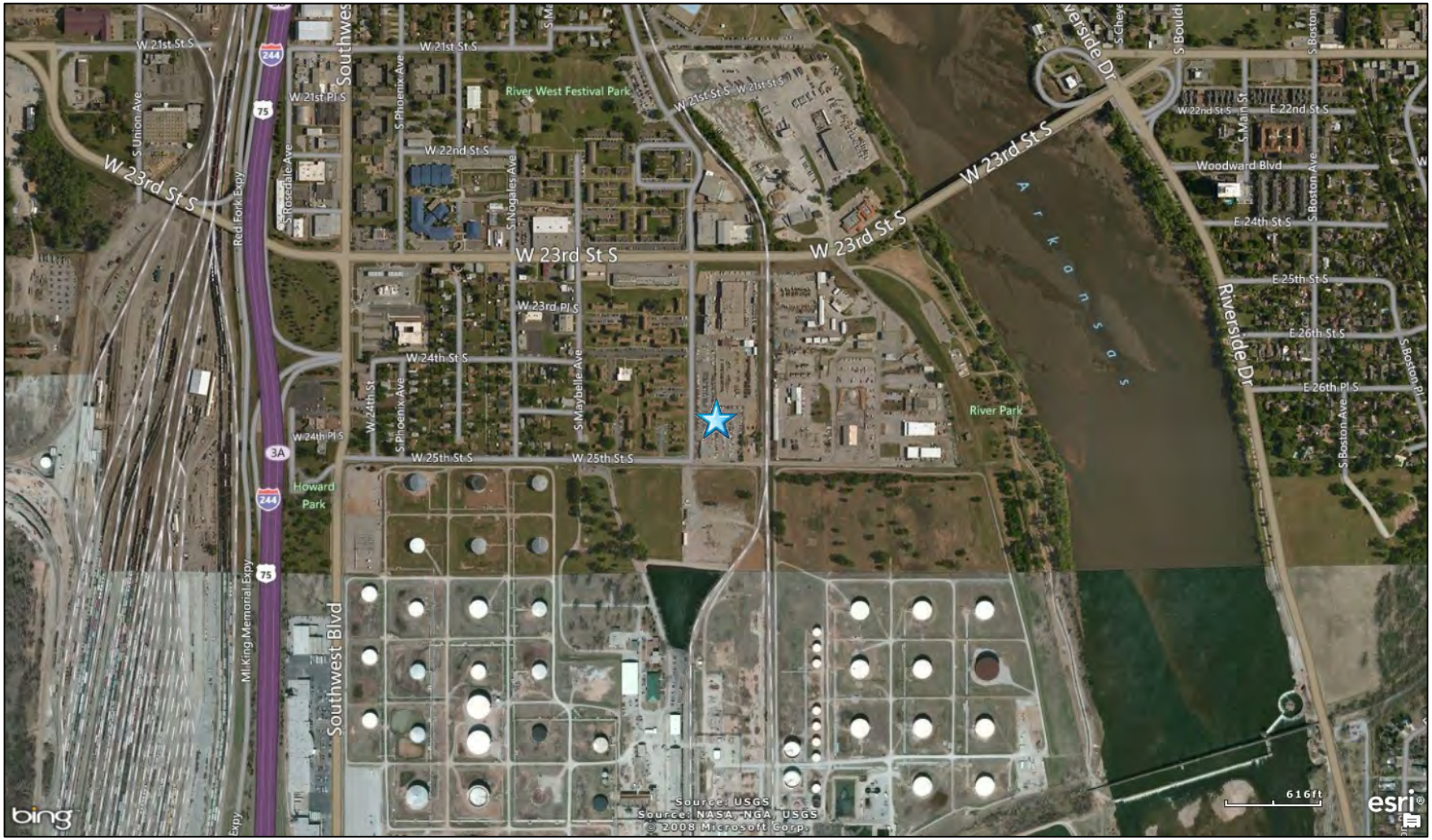


Figure 18-2. Fire Station, Tulsa, Oklahoma (TMOK) Monitoring Site

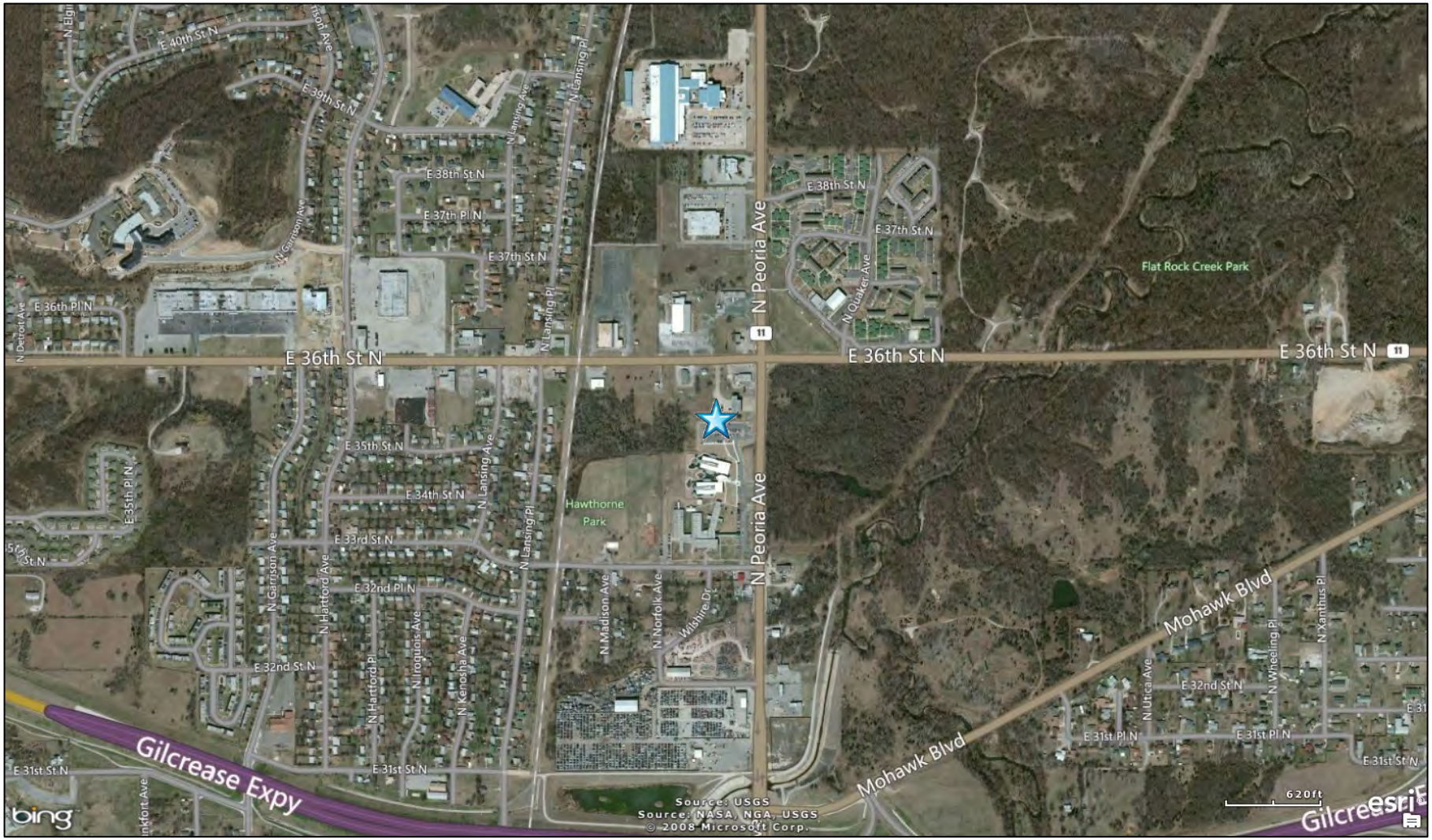


Figure 18-3. Riverside, Tulsa, Oklahoma (TROK) Monitoring Site

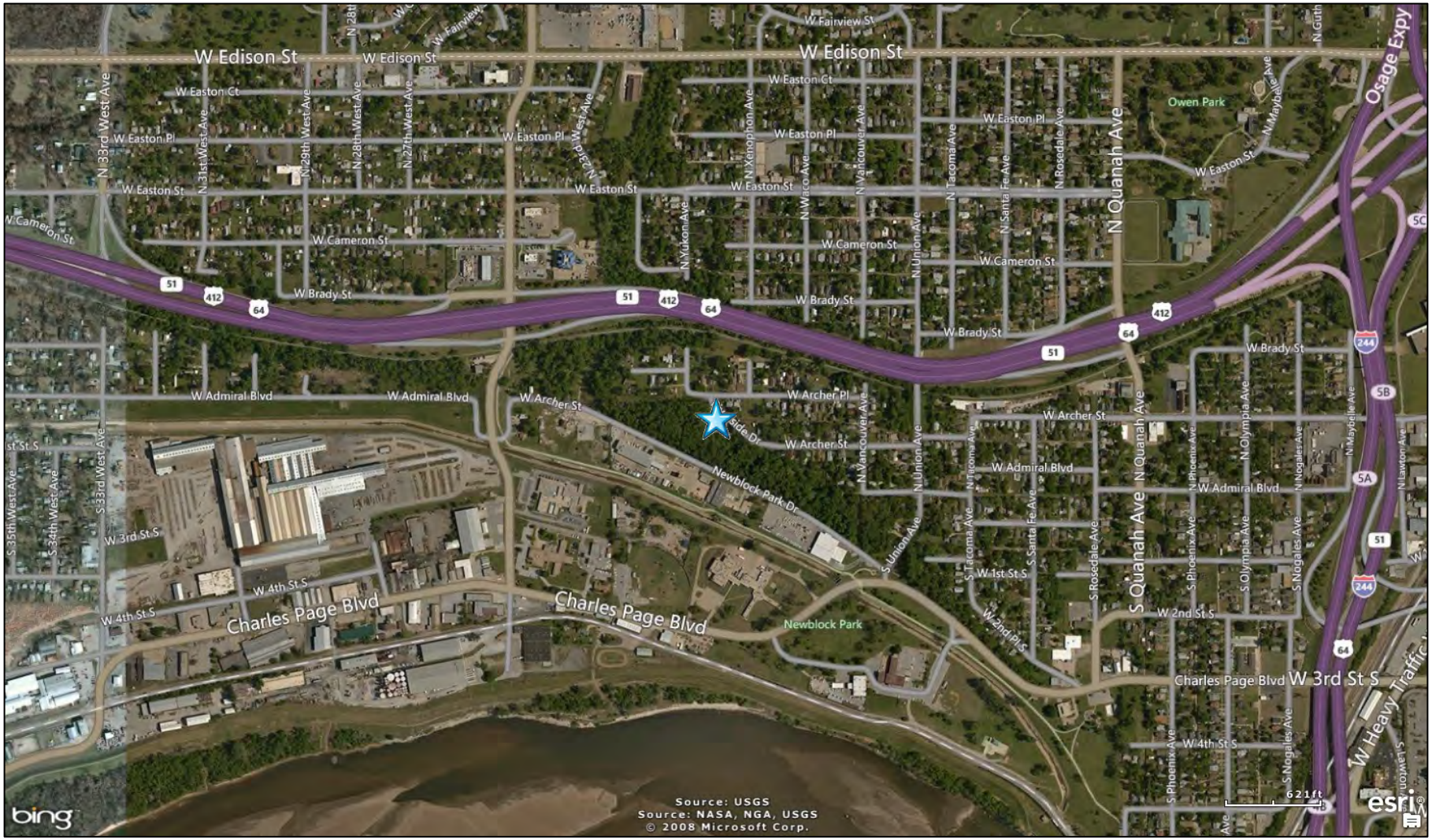


Figure 18-4. NEI Point Sources Located Within 10 Miles of TMOK, TOOK, and TROK

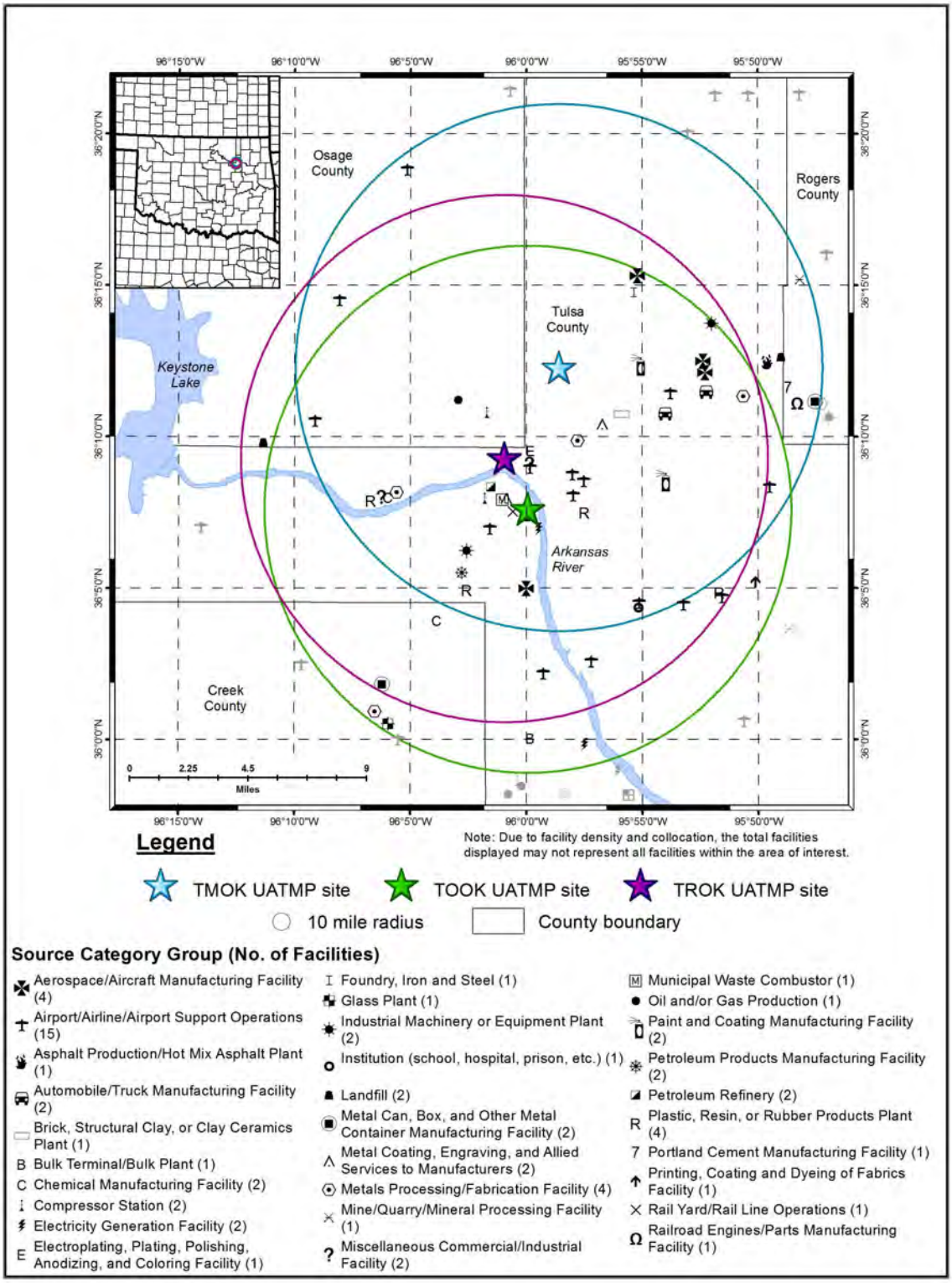


Figure 18-5. Oklahoma City, Oklahoma (OCOK) Monitoring Site

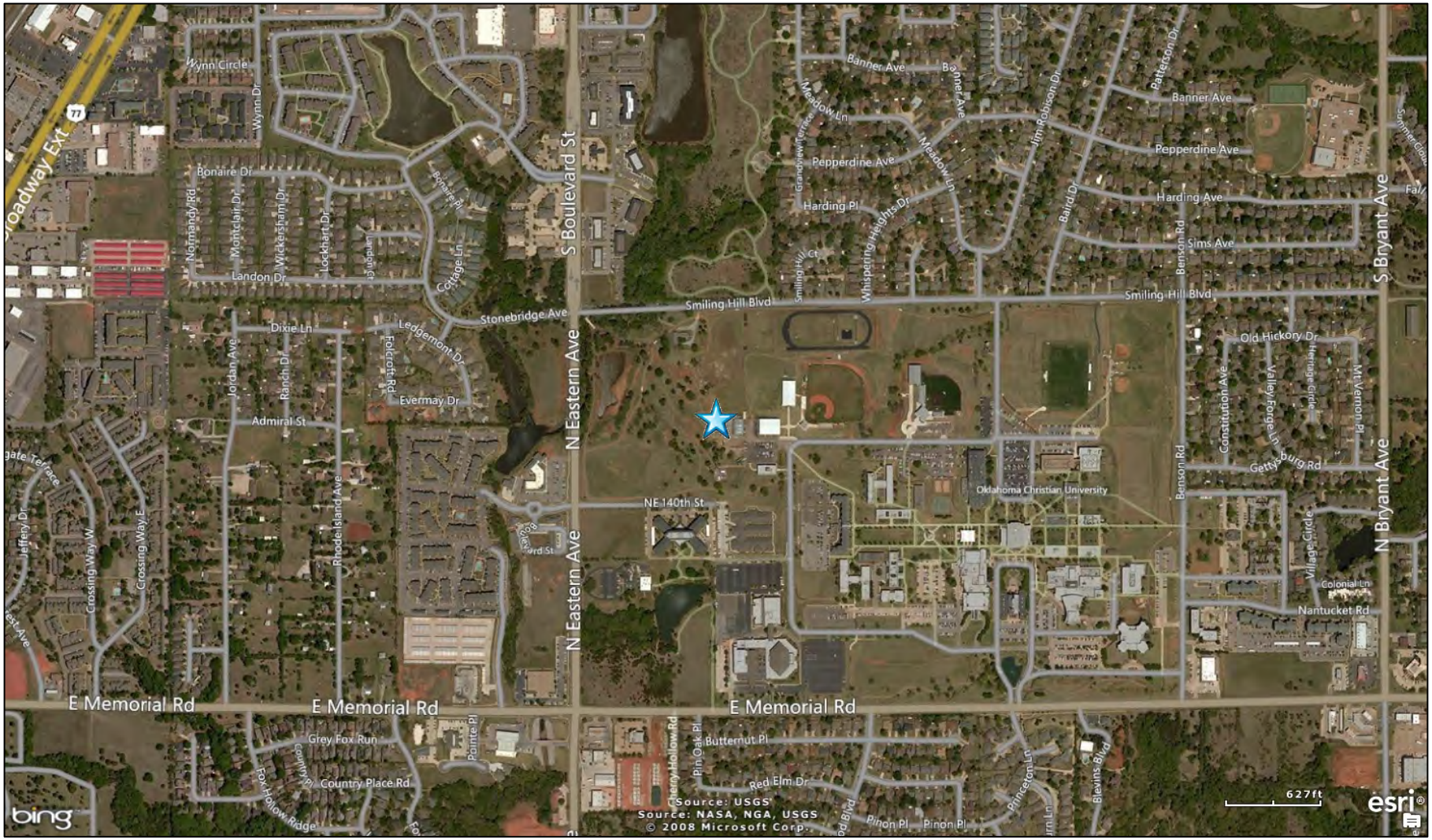


Figure 18-6. Near-road, Oklahoma City, Oklahoma (NROK) Monitoring Site

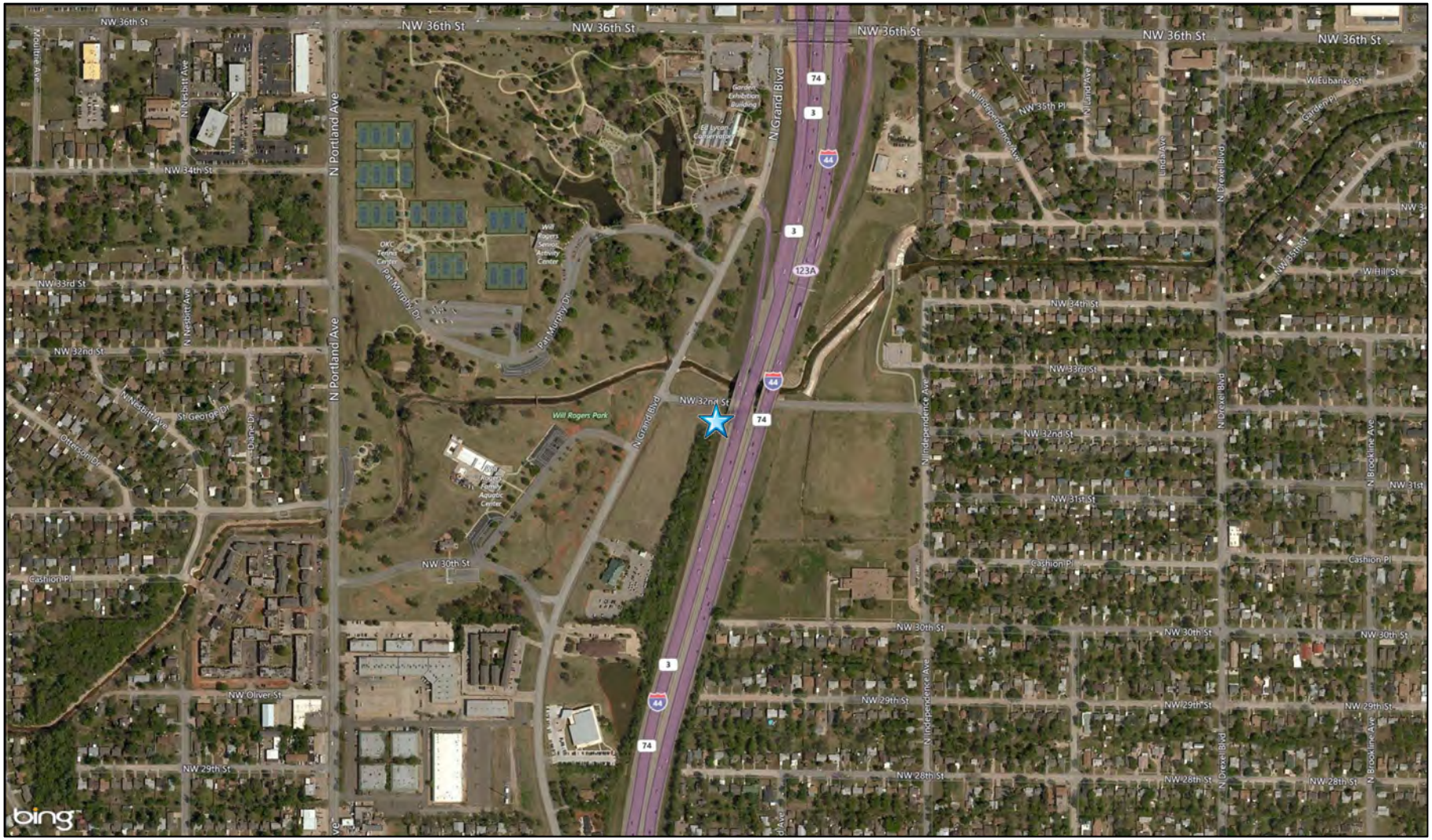


Figure 18-7. Yukon, Oklahoma (YUOK) Monitoring Site

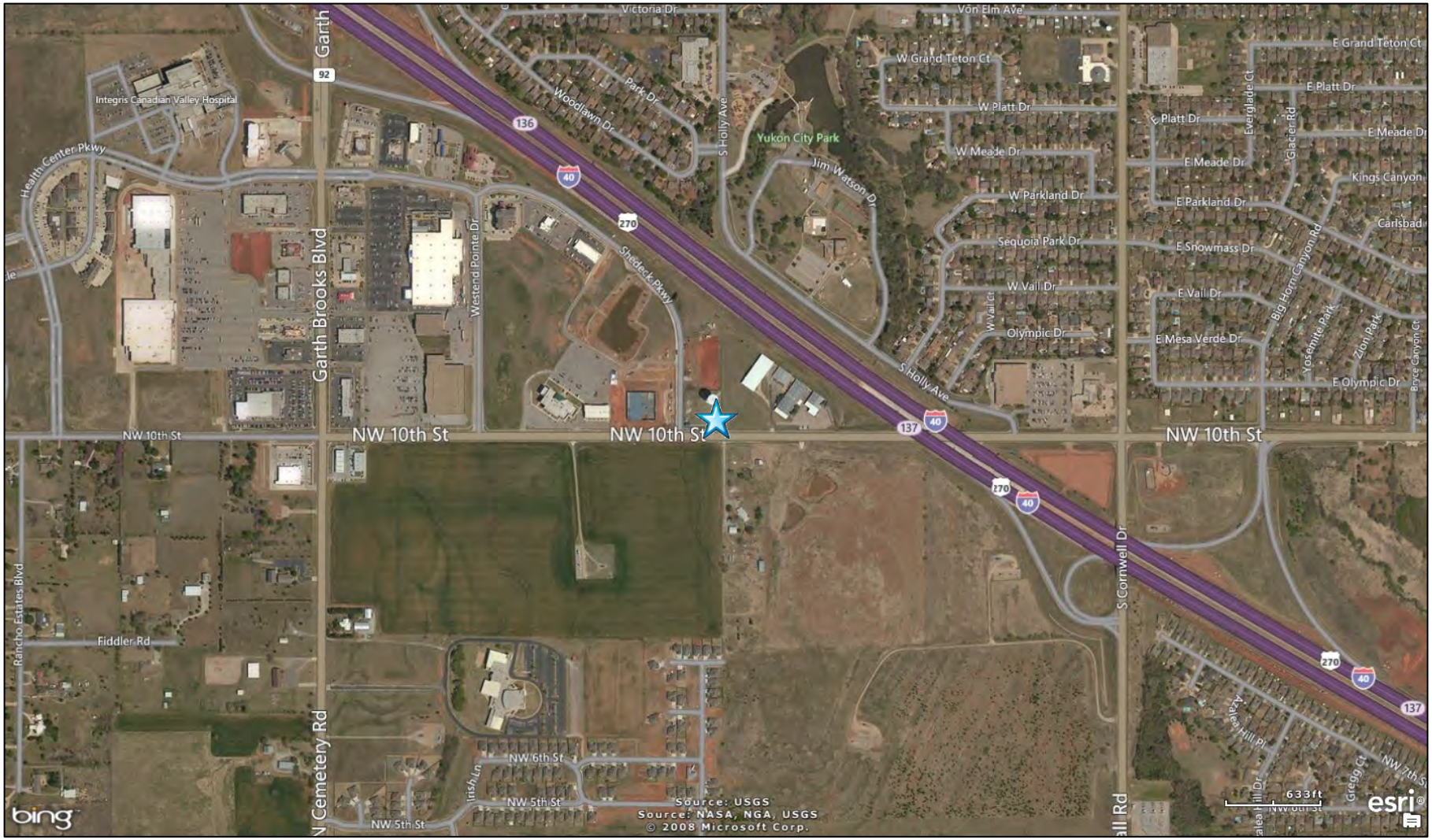


Figure 18-8. NEI Point Sources Located Within 10 Miles of NROK, OCOK, and YUOK

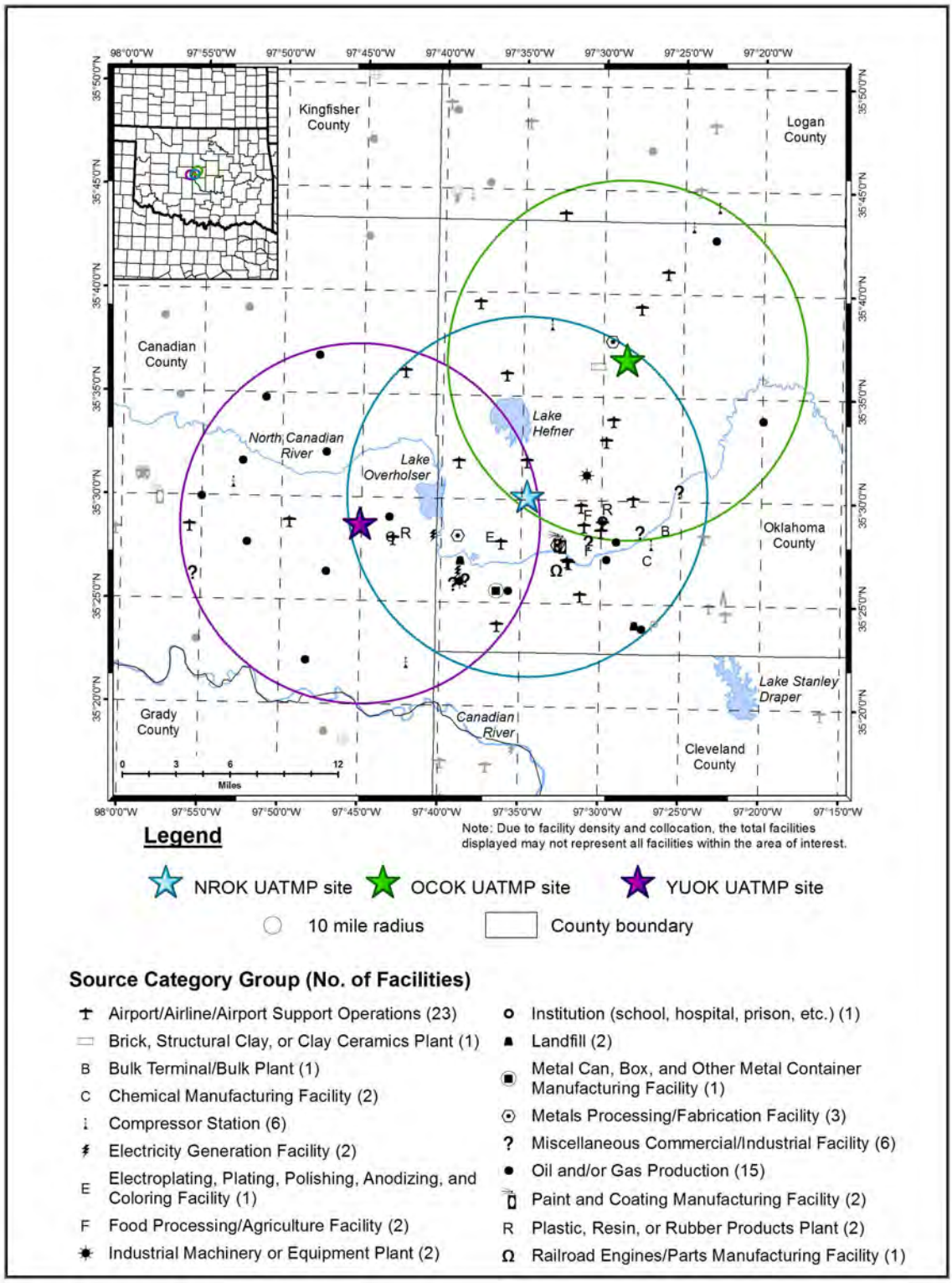


Figure 18-9. Bradley, Oklahoma (BROK) Monitoring Site

Figure 18-10. NEI Point Sources Located Within 10 Miles of BROK

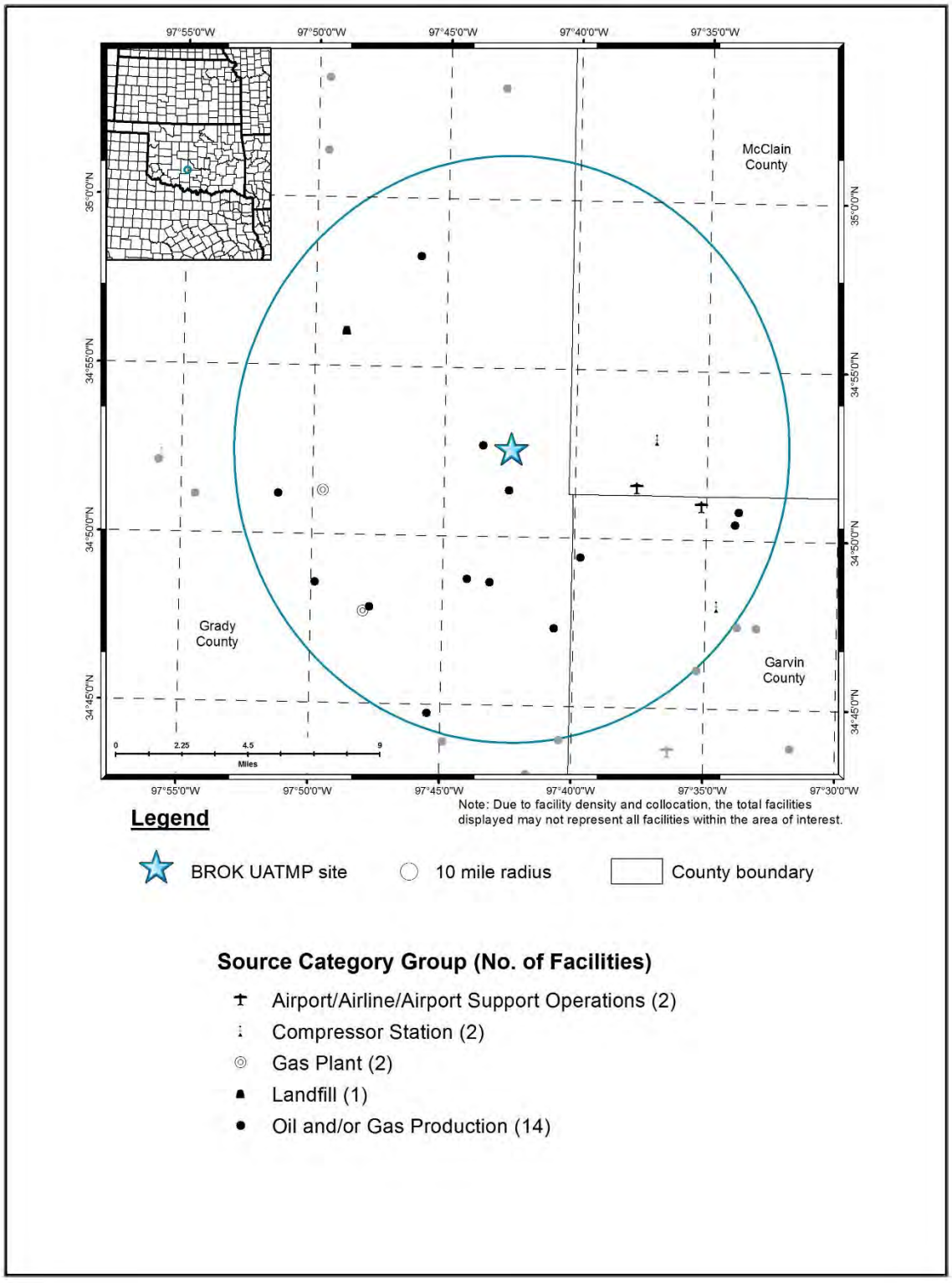


Table 18-1. Geographical Information for the Oklahoma Monitoring Sites

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Annual Average Daily Traffic[1]	Intersection Used for Traffic Data
TOOK	40-143-0235	Tulsa	Tulsa	Tulsa, OK	36.126945, -95.998941	Industrial	Urban/City Center	66,800	I-244, west side of loop
TMOK	40-143-1127	Tulsa	Tulsa	Tulsa, OK	36.204902, -95.976537	Residential	Urban/City Center	4,400	E 36th St N/11, west of US-75
TROK	40-143-0179	Tulsa	Tulsa	Tulsa, OK	36.154830, -96.015845	Industrial	Urban/City Center	55,400	Hwy 64/51/412, west of I-244
OCOK	40-109-1037	Oklahoma City	Oklahoma	Oklahoma City, OK	35.614131, -97.475083	Residential	Suburban	52,500	US-77, north of 44 (Turnpike), before bend
NROK	40-109-0097	Oklahoma City	Oklahoma	Oklahoma City, OK	35.502979, -97.577661	Commercial	Urban/City Center	167,600	I-44, south of NW 39th Expressway
YUOK	40-017-0101	Yukon	Canadian	Oklahoma City, OK	35.479215, -97.751503	Commercial	Suburban	42,900	I-40, west of Hwy 4 (east of Exit 132)
BROK	40-051-0065	Bradley	Grady	Oklahoma City, OK	34.87696, -97.70748	Residential	Rural	3,100	Hwy-19, between Alex and Bradley

[1]AADT reflects 2015 data (OK DOT, 2015)

TOOK is located in West Tulsa, on the southwest side of the Arkansas River. The site is located in the parking lot of the Public Works building. This location is between the Arkansas River and I-244, which runs parallel to Southwest Boulevard. The surrounding area is primarily industrial, although residential areas are located immediately west of the site. The site is located near the City of Tulsa West Maintenance Yard, which includes a public access CNG station. As shown in Figure 18-1, an oil refinery is located on the south side of West 25th Street South, south of TOOK. Another refinery is located to the northwest of the site, on the other side of I-244, though not visible in the figure. A rail yard is also located on the west side of I-244, which can be seen on left-hand side of Figure 18-1.

TMOK is located in north Tulsa on the property of Fire Station Number 24. As shown in Figure 18-2, the intersection of North Peoria Avenue (Highway 11) and East 36th Street North lies just to the northeast of the site. The surrounding area is primarily residential, with wooded areas just to the east, an early childhood education facility and an elementary school to the south, and a park to the west.

The TROK monitoring site is located west of downtown Tulsa, less than one-half mile north of the Arkansas River and north-northwest of the TOOK site. Although the area surrounding the TROK monitoring site is classified as industrial, the site is immediately adjacent to a residential dwelling, less than one-quarter mile south of Highway 412/51 (Sand Springs Expressway). The site is elevated above the river, and a wooded area separates the residential area from the industrial areas west of Newblock Park, as shown in Figure 18-3.

Figure 18-4 shows that the Tulsa sites are located approximately 5 miles apart, with TMOK farthest north and TOOK farthest south. Many of the emissions sources are clustered around TOOK and TROK, while there are no point sources within 2 miles of TMOK. A number of the emissions sources are located along a diagonal line running northeast-southwest through the center of Tulsa County. There are a variety of industries in the area although the source category with the greatest number of sources surrounding the Tulsa sites is the airport source category, which includes airports and related operations as well as small runways and heliports, such as those associated with hospitals or television stations. Point sources located within one mile of TOOK include a petroleum refinery; a petroleum products manufacturing facility; a rail yard; a metal coating, engraving, and allied services to manufacturers facility; and a facility generating electricity via combustion. The closest point source in the 2014 NEI is just over one mile east of TROK; this point source is in the miscellaneous commercial/industrial facility

category. Several of the facilities closest to TROK are also among the closest to TOOK. However, several industrial facilities are located between the site and river but are not included in the NEI for point sources. The two point sources within 3 miles of TMOK are involved in metal coating, engraving, and allied services and metals processing and fabrication.

OCOK is located in northern Oklahoma City, on the property of Oklahoma Christian University of Science and Arts. The site is located in the northwest corner of the University, near the athletic fields. The areas surrounding the university are primarily residential. Heavily traveled roadways such as I-35 and I-44 to the east and John Kilpatrick Turnpike to the south are within a few miles of the site, although outside the boundaries of Figure 18-5.

The NROK site is located in northwest Oklahoma City. The site serves as a near-road site and is located just off I-44, near exit 123, where the highway crosses NW 32nd Street, as shown in Figure 18-6. This location is just over a half-mile south of the I-44 and NW 39th Expressway junction. Residential areas are located on the east side of the highway and the Will Rogers Park and Gardens complex is located to the west.

The YUOK site is located in Yukon, a town to the west of Oklahoma City and in neighboring Canadian County. The monitoring site is located at the Integris water tower, just south of I-40. The site is located in a primarily commercial area, although the area north of I-40 is highly residential and the area to the south is of mixed usage. An oil well pump jack is located to the southwest of YUOK, which is shown in the middle of the green field to the southwest of YUOK in Figure 18-7. Yukon is a rapidly growing area, with both commercial and residential development.

Figure 18-8 shows the orientation of the Oklahoma City sites, with NROK located about mid-way between YUOK to the west-southwest and OCOK to the northeast. Most of the point sources located within 10 miles of these sites are located in the center of Oklahoma City (east and south of NROK). The source categories with the greatest number of sources surrounding these sites are the airport source category and the oil and gas production category. The point source closest to OCOK is involved in metals processing and fabrication. The point source closest to NROK is a heliport. The source closest to YUOK is an oil and gas production facility.

The BROK site is located in the town of Bradley, 42 miles south of Oklahoma City. The site is located on the property of the Bradley Fire Department, behind the Post Office, just south of Highway 19, as shown in Figure 18-9. The surrounding area is rural in nature, with mostly

residential properties surrounding the site. A church and playground are located farther down Parker Street. This site was established to monitor for air quality effects related to oil and gas production, but related activities have decreased in the area (OK DEQ, 2017). Figure 18-10 shows that most of the point sources within 10 miles of BROK are involved in oil and gas production, including the only two sources within a few miles of the site.

In addition to providing city, county, CBSA, and land use/location setting information, Table 18-1 also contains traffic volume information for each site as well as the location for which the traffic volume was obtained. This information is provided because emissions from motor vehicles can significantly affect concentrations measured at a given monitoring site. Among the Tulsa sites, the traffic volume passing the TMOK site is considerably less than the traffic volume near the other two Tulsa sites. For the Oklahoma City sites, the traffic volume near NROK is significantly higher than the traffic near OCOK and YUOK. Not surprisingly, the traffic volume near BROK is the lowest among the Oklahoma sites. The traffic data for NROK ranks 5th highest among all NMP sites; the traffic data for TOOK, TROK, OCOK, and YUOK rank between 16th and 21st highest among NMP sites; the traffic data for TMOK and BROK are in the bottom third compared to other NMP sites.

18.2 Pollutants of Interest

The risk-based screening process described in Section 3.2 was performed for each site to identify site-specific "pollutants of interest," which allows analysts and readers to focus on a subset of pollutants through the context of risk. For each site, each pollutant's preprocessed daily measurement was compared to its associated risk screening value. If the concentration was greater than the risk screening value, then the concentration "failed the screen." The site-specific results of this risk-based screening process are presented in Table 18-2 and incorporate measurements from both 2015 and 2016. Pollutants of interest are those for which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens and are shaded in gray in Table 18-2. It is important to note which pollutants were sampled for at each site when reviewing the results of this analysis. VOCs, carbonyl compounds, and metals (TSP) were sampled for at all three Tulsa sites, OCOK, and YUOK. VOCs, SNMOCs, and carbonyl compounds were sampled for at BROK and NROK. In addition, canister samples collected at BROK and NROK were also analyzed for methane.

Table 18-2. 2015-2016 Risk-Based Screening Results for the Oklahoma Monitoring Sites

Pollutant	Screening Value ($\mu g/m^3$)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Public Works, Tulsa, Oklahoma - TOOK						
Acetaldehyde	0.45	121	121	100.00	12.22	12.22
Formaldehyde	0.077	121	121	100.00	12.22	24.44
Arsenic (TSP)	0.00023	120	121	99.17	12.12	36.57
Benzene	0.13	120	120	100.00	12.12	48.69
Carbon Tetrachloride	0.17	120	120	100.00	12.12	60.81
1,3-Butadiene	0.03	109	117	93.16	11.01	71.82
1,2-Dichloroethane	0.038	106	106	100.00	10.71	82.53
Ethylbenzene	0.4	49	120	40.83	4.95	87.47
Manganese (TSP)	0.03	39	121	32.23	3.94	91.41
Nickel (TSP)	0.0021	30	121	24.79	3.03	94.44
p-Dichlorobenzene	0.091	16	79	20.25	1.62	96.06
Hexachloro-1,3-butadiene	0.045	14	19	73.68	1.41	97.47
Propionaldehyde	0.8	10	120	8.33	1.01	98.48
Cadmium (TSP)	0.00056	6	121	4.96	0.61	99.09
1,2-Dibromoethane	0.0017	4	4	100.00	0.40	99.49
Lead (TSP)	0.015	4	121	3.31	0.40	99.90
Trichloroethylene	0.2	1	27	3.70	0.10	100.00
Total		990	1,679	58.96		
Fire Station, Tulsa, Oklahoma - TMOK						
Acetaldehyde	0.45	120	120	100.00	12.78	12.78
Benzene	0.13	120	120	100.00	12.78	25.56
Carbon Tetrachloride	0.17	120	120	100.00	12.78	38.34
Formaldehyde	0.077	120	120	100.00	12.78	51.12
Arsenic (TSP)	0.00023	113	120	94.17	12.03	63.15
1,2-Dichloroethane	0.038	111	111	100.00	11.82	74.97
1,3-Butadiene	0.03	110	115	95.65	11.71	86.69
Ethylbenzene	0.4	42	120	35.00	4.47	91.16
p-Dichlorobenzene	0.091	33	83	39.76	3.51	94.68
Hexachloro-1,3-butadiene	0.045	18	19	94.74	1.92	96.59
Manganese (TSP)	0.03	10	120	8.33	1.06	97.66
1,2-Dibromoethane	0.0017	6	6	100.00	0.64	98.30
Nickel (TSP)	0.0021	6	120	5.00	0.64	98.94
Cadmium (TSP)	0.00056	5	120	4.17	0.53	99.47
Propionaldehyde	0.8	2	118	1.69	0.21	99.68
Trichloroethylene	0.2	2	27	7.41	0.21	99.89
Lead (TSP)	0.015	1	120	0.83	0.11	100.00
Total		939	1,679	55.93		

Table 18-2. 2015-2016 Risk-Based Screening Results for the Oklahoma Monitoring Sites (Continued)

Pollutant	Screening Value (µg/m^3)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Riverside, Tulsa, Oklahoma - TROK						
Benzene	0.13	121	121	100.00	12.90	12.90
Carbon Tetrachloride	0.17	121	121	100.00	12.90	25.80
Acetaldehyde	0.45	120	120	100.00	12.79	38.59
Formaldehyde	0.077	120	120	100.00	12.79	51.39
Arsenic (TSP)	0.00023	119	121	98.35	12.69	64.07
1,3-Butadiene	0.03	110	119	92.44	11.73	75.80
1,2-Dichloroethane	0.038	110	110	100.00	11.73	87.53
Ethylbenzene	0.4	39	121	32.23	4.16	91.68
Hexachloro-1,3-butadiene	0.045	18	19	94.74	1.92	93.60
Nickel (TSP)	0.0021	16	121	13.22	1.71	95.31
p-Dichlorobenzene	0.091	14	67	20.90	1.49	96.80
Manganese (TSP)	0.03	10	121	8.26	1.07	97.87
1,2-Dibromoethane	0.0017	9	9	100.00	0.96	98.83
Propionaldehyde	0.8	5	117	4.27	0.53	99.36
Cadmium (TSP)	0.00056	3	121	2.48	0.32	99.68
1,1,2-Trichloroethane	0.0625	2	4	50.00	0.21	99.89
Lead (TSP)	0.015	1	121	0.83	0.11	100.00
Total		938	1,653	56.75		
Oklahoma City, Oklahoma - OCOK						
Benzene	0.13	121	121	100.00	14.67	14.67
Acetaldehyde	0.45	120	120	100.00	14.55	29.21
Carbon Tetrachloride	0.17	120	121	99.17	14.55	43.76
Formaldehyde	0.077	120	120	100.00	14.55	58.30
1,2-Dichloroethane	0.038	110	111	99.10	13.33	71.64
Arsenic (TSP)	0.00023	108	120	90.00	13.09	84.73
1,3-Butadiene	0.03	77	104	74.04	9.33	94.06
Hexachloro-1,3-butadiene	0.045	15	19	78.95	1.82	95.88
Manganese (TSP)	0.03	7	120	5.83	0.85	96.73
1,2-Dibromoethane	0.0017	6	6	100.00	0.73	97.45
p-Dichlorobenzene	0.091	5	44	11.36	0.61	98.06
Trichloroethylene	0.2	5	23	21.74	0.61	98.67
Ethylbenzene	0.4	4	121	3.31	0.48	99.15
Nickel (TSP)	0.0021	3	120	2.50	0.36	99.52
Propionaldehyde	0.8	3	120	2.50	0.36	99.88
Cadmium (TSP)	0.00056	1	120	0.83	0.12	100.00
Total		825	1,510	54.64		

Table 18-2. 2015-2016 Risk-Based Screening Results for the Oklahoma Monitoring Sites (Continued)

Pollutant	Screening Value (µg/m^3)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Near-road, Oklahoma City, Oklahoma - NROK						
Acetaldehyde	0.45	38	38	100.00	13.77	13.77
Benzene	0.13	38	38	100.00	13.77	27.54
Carbon Tetrachloride	0.17	38	38	100.00	13.77	41.30
Formaldehyde	0.077	38	38	100.00	13.77	55.07
1,3-Butadiene	0.03	37	38	97.37	13.41	68.48
1,2-Dichloroethane	0.038	32	32	100.00	11.59	80.07
Ethylbenzene	0.4	28	38	73.68	10.14	90.22
p-Dichlorobenzene	0.091	16	32	50.00	5.80	96.01
Hexachloro-1,3-butadiene	0.045	10	10	100.00	3.62	99.64
1,2-Dibromoethane	0.0017	1	1	100.00	0.36	100.00
Total		276	303	91.09		
Yukon, Oklahoma - YUOK						
Acetaldehyde	0.45	120	120	100.00	14.67	14.67
Benzene	0.13	120	120	100.00	14.67	29.34
Carbon Tetrachloride	0.17	120	120	100.00	14.67	44.01
Formaldehyde	0.077	120	120	100.00	14.67	58.68
1,2-Dichloroethane	0.038	113	114	99.12	13.81	72.49
Arsenic (TSP)	0.00023	106	120	88.33	12.96	85.45
1,3-Butadiene	0.03	73	108	67.59	8.92	94.38
Hexachloro-1,3-butadiene	0.045	13	15	86.67	1.59	95.97
Manganese (TSP)	0.03	9	120	7.50	1.10	97.07
1,2-Dibromoethane	0.0017	8	8	100.00	0.98	98.04
Ethylbenzene	0.4	7	120	5.83	0.86	98.90
Nickel (TSP)	0.0021	4	120	3.33	0.49	99.39
p-Dichlorobenzene	0.091	3	49	6.12	0.37	99.76
Cadmium (TSP)	0.00056	1	120	0.83	0.12	99.88
1,1,2-Trichloroethane	0.0625	1	5	20.00	0.12	100.00
Total		818	1,379	59.32		

Table 18-2. 2015-2016 Risk-Based Screening Results for the Oklahoma Monitoring Sites (Continued)

Pollutant	Screening Value (µg/m^3)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Bradley, Oklahoma - BROK						
Acetaldehyde	0.45	100	100	100.00	18.28	18.28
Formaldehyde	0.077	100	100	100.00	18.28	36.56
Benzene	0.13	98	98	100.00	17.92	54.48
Carbon Tetrachloride	0.17	97	98	98.98	17.73	72.21
1,2-Dichloroethane	0.038	90	90	100.00	16.45	88.67
1,3-Butadiene	0.03	29	74	39.19	5.30	93.97
Propionaldehyde	0.8	13	100	13.00	2.38	96.34
Hexachloro-1,3-butadiene	0.045	9	9	100.00	1.65	97.99
p-Dichlorobenzene	0.091	5	24	20.83	0.91	98.90
Ethylbenzene	0.4	4	97	4.12	0.73	99.63
1,2-Dibromoethane	0.0017	2	2	100.00	0.37	100.00
Total		547	792	69.07		

Observations from Table 18-2 include the following:

- Concentrations of 17 pollutants failed at least one screen for TOOK; nearly 59 percent of concentrations for these 17 pollutants were greater than their associated risk screening value (or failed screens).

- Concentrations of 11 pollutants contributed to 95 percent of failed screens for TOOK and therefore were identified as pollutants of interest for this site. These 11 include two carbonyl compounds, six VOCs, and three TSP metals. TOOK is one of only two NMP sites for which manganese was identified as a pollutant of interest.

- Concentrations of 17 pollutants failed at least one screen for TMOK; nearly 56 percent of concentrations for these 17 pollutants were greater than their associated risk screening value (or failed screens).

- Concentrations of 10 pollutants contributed to 95 percent of failed screens for TMOK and therefore were identified as pollutants of interest for this site. These 10 include two carbonyl compounds, seven VOCs, and one TSP metal.

- Concentrations of 17 pollutants failed at least one screen for TROK; nearly 57 percent of concentrations for these 17 pollutants were greater than their associated risk screening value (or failed screens).

- Concentrations of 10 pollutants contributed to 95 percent of failed screens for TROK and therefore were identified as pollutants of interest for this site. These 10 include two carbonyl compounds, six VOCs, and two TSP metals.

- Concentrations of 16 pollutants failed at least one screen for OCOK; nearly 55 percent of concentrations for these 16 pollutants were greater than their associated risk screening value (or failed screens).

- Concentrations of eight pollutants contributed to 95 percent of failed screens for OCOK and therefore were identified as pollutants of interest for this site. These eight include two carbonyl compounds, five VOCs, and one TSP metal.

- Concentrations of 10 pollutants failed at least one screen for NROK; 91 percent of concentrations for these 10 pollutants were greater than their associated risk screening value (or failed screens).

- Concentrations of eight pollutants contributed to 95 percent of failed screens for NROK and therefore were identified as pollutants of interest for this site. These eight include two carbonyl compounds and six VOCs.

- Concentrations of 15 pollutants failed at least one screen for YUOK; 59 percent of concentrations for these 15 pollutants were greater than their associated risk screening value (or failed screens).

- Concentrations of eight pollutants contributed to 95 percent of failed screens for YUOK and therefore were identified as pollutants of interest for this site. These eight include two carbonyl compounds, five VOCs, and one TSP metal.

- Concentrations of 11 pollutants failed at least one screen for BROK; 69 percent of concentrations for these 11 pollutants were greater than their associated risk screening value (or failed screens).

- Concentrations of seven pollutants contributed to 95 percent of failed screens for BROK and therefore were identified as pollutants of interest for this site. These seven include three carbonyl compounds and four VOCs. BROK is one of only two NMP sites for which propionaldehyde was identified as a pollutant of interest.

- The number of pollutants identified as pollutants of interest range from seven (BROK) to 11 (TOOK) among the Oklahoma sites. The Tulsa sites each have at least 10 pollutants of interest while the Oklahoma City sites have eight, and BROK has seven.

- Note that sampling at BROK began in April 2015 and sampling at NROK began in May 2016.

- As described in Section 3.2, if a pollutant was measured by both the TO-15 and SNMOC methods at the same site, the TO-15 results were used for the risk-based screening process. As BROK and NROK sampled both VOCs (TO-15) and SNMOCs, the TO-15 results were used for the 12 pollutants these methods have in common.

- The Oklahoma sites have six pollutants of interest in common: acetaldehyde, benzene, 1,3-butadiene, carbon tetrachloride, 1,2-dichloroethane, and formaldehyde. If the two sites not sampling metals are excluded (NROK and BROK), arsenic would also be on this list.

- Concentrations measured at TOOK failed the fourth highest number of screens among NMP sites, with other five Oklahoma sites that sampled over the full two years ranking in the top third, as shown in Table 4-9.

For each of the data analyses described in the remaining sections, the focus is on the site-specific pollutants of interest identified via the risk-based screening process, as described in Section 3.4.2.

18.3 Concentrations

This section presents various concentration averages used to characterize air toxics concentration levels at the Oklahoma monitoring sites. Where applicable, the following calculations and data analyses were performed for each of the site-specific pollutants of interest:

- Time period-based concentration averages (quarterly and annual) are provided for each monitoring site for each year.

- The range of measurements and annual concentration averages are presented graphically for each site to illustrate how the site's concentrations compare to the program-level averages, as presented in Section 4.1.

- Concentration averages and other statistical metrics for 2015, 2016, and from previous years of monitoring are presented in order to characterize concentration trends at each site.

Each data analysis is performed where the applicable criteria are met (as specified in the appropriate sections discussed below) and is limited to the site-specific pollutants of interest.

Methane is not a HAP, and therefore has no risk screening value. Thus, methane results are automatically excluded from the sections that follow. However, Appendix D provides individual methane measurements and Appendix L provides statistical summaries for the period of sampling for BROK and NROK. Similarly, site-specific statistical summaries for all pollutants sampled for at the Oklahoma sites are provided in Appendices J through M and O.

18.3.1 2015 and 2016 Concentration Averages

Quarterly and annual concentration averages for 2015 and 2016 were calculated for the pollutants of interest for each Oklahoma site, as described in Section 3.1. The *quarterly average concentration* of a particular pollutant is simply the average concentration of the preprocessed daily measurements over a given calendar quarter. Quarterly average concentrations include the substitution of zeros for all non-detects. A site must have a minimum of 75 percent valid samples compared to the total number of samples possible within a given calendar quarter for a quarterly average to be calculated. An *annual average concentration* includes all measured detections and substituted zeros for non-detects for an entire year of sampling. Annual averages were calculated for pollutants where three valid quarterly averages could be calculated for a given year and where method completeness was greater than or equal to 85 percent, as presented in Section 2.4. Quarterly and annual average concentrations for the pollutants of interest for the Oklahoma monitoring sites are presented in Table 18-3, where applicable. Note that concentrations of the TSP metals are presented in ng/m^3 for ease of viewing. Also note that if a pollutant was not detected in a given calendar quarter, the quarterly average simply reflects "0" because only zeros substituted for non-detects were factored into the quarterly average concentration.

Table 18-3. Quarterly and Annual Average Concentrations of the Pollutants of Interest for the Oklahoma Monitoring Sites

Pollutant	2015						2016					
	# of Detects/ # >MDL/ # Samples	Q1 Avg (µg/m³)	Q2 Avg (µg/m³)	Q3 Avg (µg/m³)	Q4 Avg (µg/m³)	Annual Average (µg/m³)	# of Detects/ # >MDL/ # Samples	Q1 Avg (µg/m³)	Q2 Avg (µg/m³)	Q3 Avg (µg/m³)	Q4 Avg (µg/m³)	Annual Average (µg/m³)
Public Works, Tulsa, Oklahoma - TOOK												
Acetaldehyde	60/60/60	1.52 ± 0.33	2.11 ± 0.41	2.56 ± 0.34	1.88 ± 0.51	2.02 ± 0.21	61/61/61	1.61 ± 0.30	1.92 ± 0.36	2.33 ± 0.23	2.06 ± 0.47	1.97 ± 0.18
Benzene	59/59/59	0.91 ± 0.22	0.90 ± 0.13	1.31 ± 0.21	1.23 ± 0.35	1.09 ± 0.12	61/61/61	1.23 ± 0.33	0.85 ± 0.18	0.90 ± 0.17	1.33 ± 0.29	1.08 ± 0.13
1,3-Butadiene	56/53/59	0.07 ± 0.02	0.06 ± 0.01	0.05 ± 0.02	0.10 ± 0.05	0.07 ± 0.01	61/35/61	0.11 ± 0.03	0.06 ± 0.02	0.06 ± 0.02	0.11 ± 0.04	0.08 ± 0.01
Carbon Tetrachloride	59/59/59	0.58 ± 0.04	0.6 ± 0.02	0.66 ± 0.04	0.60 ± 0.02	0.61 ± 0.02	61/61/61	0.57 ± 0.04	0.67 ± 0.05	0.61 ± 0.05	0.61 ± 0.04	0.61 ± 0.02
p-Dichlorobenzene	48/2/59	0.05 ± 0.01	0.05 ± 0.01	0.04 ± 0.02	0.08 ± 0.04	0.06 ± 0.01	31/2/61	0.05 ± 0.02	0.04 ± 0.02	0.03 ± 0.02	0.07 ± 0.05	0.05 ± 0.02
1,2-Dichloroethane	51/49/59	0.11 ± 0.01	0.06 ± 0.03	0.07 ± 0.02	0.12 ± 0.02	0.09 ± 0.01	55/55/61	0.12 ± 0.01	0.12 ± 0.02	0.06 ± 0.02	0.10 ± 0.02	0.10 ± 0.01
Ethylbenzene	59/59/59	0.30 ± 0.09	0.36 ± 0.06	0.41 ± 0.12	0.54 ± 0.18	0.40 ± 0.06	61/61/61	0.48 ± 0.18	0.37 ± 0.12	0.43 ± 0.12	0.60 ± 0.21	0.47 ± 0.08
Formaldehyde	60/60/60	1.78 ± 0.31	2.85 ± 0.84	4.53 ± 0.63	2.18 ± 0.45	2.84 ± 0.39	61/61/61	2.38 ± 0.55	3.79 ± 0.82	4.82 ± 0.59	2.41 ± 0.38	3.33 ± 0.39
Arsenic (TSP)[a]	60/60/60	0.67 ± 0.11	0.69 ± 0.12	0.95 ± 0.23	0.82 ± 0.18	0.78 ± 0.08	61/61/61	0.83 ± 0.21	0.76 ± 0.18	0.84 ± 0.11	1.14 ± 0.35	0.89 ± 0.11
Manganese (TSP) [a]	60/60/60	21.78 ± 5.35	24.05 ± 8.91	29.97 ± 7.00	28.23 ± 10.47	26.01 ± 3.92	61/61/61	27.92 ± 11.24	25.41 ± 9.23	29.04 ± 5.94	25.32 ± 7.36	26.94 ± 4.15
Nickel (TSP) [a]	60/59/60	2.49 ± 1.31	1.68 ± 0.45	1.79 ± 0.23	1.85 ± 0.52	1.95 ± 0.36	61/61/61	2.35 ± 0.94	1.94 ± 0.97	2.93 ± 2.84	1.43 ± 0.34	2.17 ± 0.75

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NS = Sampling was not conducted during this time.
NR = Not reportable due to invalidation related to a contaminated internal standard.
[a] Average concentrations provided for the pollutants below the blue line are presented in ng/m³ for ease of viewing.

Table 18-3. Quarterly and Annual Average Concentrations of the Pollutants of Interest for the Oklahoma Monitoring Sites (Continued)

Pollutant	2015 # of Detects/ # >MDL/ # Samples	2015 Q1 Avg (µg/m³)	2015 Q2 Avg (µg/m³)	2015 Q3 Avg (µg/m³)	2015 Q4 Avg (µg/m³)	2015 Annual Average (µg/m³)	2016 # of Detects/ # >MDL/ # Samples	2016 Q1 Avg (µg/m³)	2016 Q2 Avg (µg/m³)	2016 Q3 Avg (µg/m³)	2016 Q4 Avg (µg/m³)	2016 Annual Average (µg/m³)
Fire Station, Tulsa, Oklahoma - TMOK												
Acetaldehyde	60/60/60	1.58 ± 0.36	2.25 ± 0.44	2.10 ± 0.24	1.42 ± 0.31	1.84 ± 0.19	60/60/60	1.42 ± 0.30	1.66 ± 0.25	2.21 ± 0.3	1.82 ± 0.37	1.77 ± 0.16
Benzene	60/60/60	0.85 ± 0.16	0.63 ± 0.14	0.92 ± 0.25	0.97 ± 0.21	0.84 ± 0.10	60/60/60	0.91 ± 0.25	0.74 ± 0.19	0.76 ± 0.21	1.21 ± 0.29	0.90 ± 0.12
1,3-Butadiene	56/53/60	0.09 ± 0.04	0.07 ± 0.02	0.08 ± 0.03	0.10 ± 0.04	0.09 ± 0.02	59/41/60	0.13 ± 0.05	0.08 ± 0.03	0.08 ± 0.02	0.15 ± 0.06	0.11 ± 0.02
Carbon Tetrachloride	60/60/60	0.56 ± 0.04	0.63 ± 0.03	0.67 ± 0.04	0.61 ± 0.04	0.62 ± 0.02	60/60/60	0.60 ± 0.04	0.69 ± 0.04	0.63 ± 0.04	0.61 ± 0.06	0.63 ± 0.02
p-Dichlorobenzene	42/3/60	0.04 ± 0.02	0.04 ± 0.02	0.05 ± 0.03	0.10 ± 0.03	0.06 ± 0.01	41/13/60	0.06 ± 0.04	0.06 ± 0.03	0.08 ± 0.04	0.11 ± 0.06	0.08 ± 0.02
1,2-Dichloroethane	54/51/60	0.10 ± 0.02	0.06 ± 0.03	0.07 ± 0.02	0.11 ± 0.01	0.08 ± 0.01	57/57/60	0.11 ± 0.02	0.11 ± 0.02	0.08 ± 0.02	0.10 ± 0.03	0.10 ± 0.01
Ethylbenzene	60/59/60	0.25 ± 0.07	0.29 ± 0.07	0.36 ± 0.10	0.38 ± 0.10	0.32 ± 0.04	60/58/60	0.34 ± 0.16	0.34 ± 0.11	0.41 ± 0.12	0.70 ± 0.22	0.44 ± 0.08
Formaldehyde	60/60/60	1.94 ± 0.37	3.23 ± 0.75	3.88 ± 0.58	1.81 ± 0.43	2.71 ± 0.34	60/60/60	2.31 ± 0.65	3.44 ± 0.84	4.66 ± 0.77	2.23 ± 0.32	3.16 ± 0.41
Hexachloro-1,3-butadiene	1/0/60	NR	NR	NR	NR	NR	18/0/60	0.02 ± 0.02	0.03 ± 0.03	0.03 ± 0.03	0.03 ± 0.03	0.03 ± 0.01
Arsenic (TSP) [a]	59/59/59	0.58 ± 0.18	0.56 ± 0.14	0.75 ± 0.15	0.68 ± 0.14	0.64 ± 0.07	61/61/61	0.53 ± 0.17	0.60 ± 0.13	0.70 ± 0.12	0.84 ± 0.21	0.67 ± 0.08

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NS = Sampling was not conducted during this time.
NR = Not reportable due to invalidation related to a contaminated internal standard.
[a] Average concentrations provided for the pollutants below the blue line are presented in ng/m³ for ease of viewing.
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Table 18-3. Quarterly and Annual Average Concentrations of the Pollutants of Interest for the Oklahoma Monitoring Sites (Continued)

Pollutant	2015 # of Detects/ # >MDL/ # Samples	2015 Q1 Avg (µg/m³)	2015 Q2 Avg (µg/m³)	2015 Q3 Avg (µg/m³)	2015 Q4 Avg (µg/m³)	2015 Annual Average (µg/m³)	2016 # of Detects/ # >MDL/ # Samples	2016 Q1 Avg (µg/m³)	2016 Q2 Avg (µg/m³)	2016 Q3 Avg (µg/m³)	2016 Q4 Avg (µg/m³)	2016 Annual Average (µg/m³)
Riverside, Tulsa, Oklahoma - TROK												
Acetaldehyde	59/59/59	1.55 ± 0.31	2.00 ± 0.44	2.45 ± 0.32	1.68 ± 0.34	1.92 ± 0.19	61/61/61	1.43 ± 0.27	2.06 ± 0.34	2.70 ± 0.30	1.91 ± 0.37	2.02 ± 0.19
Benzene	60/60/60	0.76 ± 0.11	0.72 ± 0.15	0.79 ± 0.09	0.88 ± 0.12	0.79 ± 0.06	61/61/61	0.84 ± 0.16	0.76 ± 0.17	0.98 ± 0.24	1.00 ± 0.20	0.89 ± 0.09
1,3-Butadiene	58/52/60	0.08 ± 0.02	0.06 ± 0.01	0.06 ± 0.02	0.08 ± 0.03	0.07 ± 0.01	61/44/61	0.10 ± 0.03	0.06 ± 0.01	0.06 ± 0.02	0.10 ± 0.02	0.08 ± 0.01
Carbon Tetrachloride	60/60/60	0.57 ± 0.04	0.58 ± 0.04	0.66 ± 0.03	0.62 ± 0.05	0.61 ± 0.02	61/61/61	0.52 ± 0.07	0.67 ± 0.04	0.60 ± 0.04	0.61 ± 0.03	0.60 ± 0.03
1,2-Dichloroethane	53/49/60	0.10 ± 0.01	0.06 ± 0.03	0.06 ± 0.02	0.09 ± 0.02	0.08 ± 0.01	57/57/61	0.10 ± 0.01	0.11 ± 0.02	0.07 ± 0.03	0.10 ± 0.01	0.10 ± 0.01
Ethylbenzene	60/59/60	0.23 ± 0.05	0.31 ± 0.07	0.36 ± 0.05	0.34 ± 0.06	0.31 ± 0.03	61/61/61	0.25 ± 0.09	0.35 ± 0.12	0.58 ± 0.16	0.46 ± 0.13	0.41 ± 0.07
Formaldehyde	59/59/59	1.81 ± 0.41	2.83 ± 0.92	4.05 ± 0.70	2.05 ± 0.48	2.67 ± 0.38	61/61/61	2.07 ± 0.41	3.25 ± 0.77	4.33 ± 0.60	2.08 ± 0.35	2.92 ± 0.35
Hexachloro-1,3-butadiene	1/0/60	NR	NR	NR	NR	NR	18/0/61	0.02 ± 0.02	0.05 ± 0.03	0.01 ± 0.02	0.03 ± 0.02	0.03 ± 0.01
Arsenic (TSP) [a]	60/60/60	0.77 ± 0.23	0.76 ± 0.25	1.00 ± 0.46	0.85 ± 0.22	0.85 ± 0.14	61/61/61	0.79 ± 0.29	0.79 ± 0.15	0.79 ± 0.15	1.43 ± 0.74	0.95 ± 0.20
Nickel (TSP) [a]	60/58/60	1.63 ± 0.51	1.41 ± 0.45	1.32 ± 0.28	1.41 ± 0.37	1.44 ± 0.19	61/60/61	1.22 ± 0.54	1.12 ± 0.24	1.32 ± 0.32	1.15 ± 0.35	1.20 ± 0.18

NA = Not available because the criteria for calculating a quarterly and/or annual average were not met.
NS = Sampling was not conducted during this time.
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[a] Average concentrations provided for the pollutants below the blue line are presented in ng/m³ for ease of viewing.

Table 18-3. Quarterly and Annual Average Concentrations of the Pollutants of Interest for the Oklahoma Monitoring Sites (Continued)

Pollutant	2015						2016					
	# of Detects/ # >MDL/ # Samples	Q1 Avg (µg/m³)	Q2 Avg (µg/m³)	Q3 Avg (µg/m³)	Q4 Avg (µg/m³)	Annual Average (µg/m³)	# of Detects/ # >MDL/ # Samples	Q1 Avg (µg/m³)	Q2 Avg (µg/m³)	Q3 Avg (µg/m³)	Q4 Avg (µg/m³)	Annual Average (µg/m³)
Oklahoma City, Oklahoma - OCOK												
Acetaldehyde	60/60/60	1.41 ± 0.38	1.96 ± 0.48	2.73 ± 0.33	1.60 ± 0.34	1.92 ± 0.22	60/60/60	1.21 ± 0.19	1.69 ± 0.29	1.92 ± 0.22	1.75 ± 0.35	1.63 ± 0.14
Benzene	60/60/60	0.64 ± 0.05	0.49 ± 0.10	0.58 ± 0.09	0.61 ± 0.08	0.58 ± 0.04	61/61/61	0.76 ± 0.42	0.44 ± 0.08	0.55 ± 0.09	0.68 ± 0.11	0.61 ± 0.11
1,3-Butadiene	50/36/60	0.04 ± 0.01	0.03 ± 0.01	0.03 ± 0.01	0.05 ± 0.02	0.04 ± 0.01	54/14/61	0.05 ± 0.02	0.03 ± 0.01	0.03 ± 0.01	0.06 ± 0.02	0.05 ± 0.01
Carbon Tetrachloride	60/60/60	0.61 ± 0.04	0.62 ± 0.03	0.68 ± 0.03	0.63 ± 0.04	0.64 ± 0.02	61/61/61	0.54 ± 0.08	0.67 ± 0.03	0.62 ± 0.05	0.63 ± 0.06	0.61 ± 0.03
1,2-Dichloroethane	56/50/60	0.10 ± 0.01	0.08 ± 0.01	0.05 ± 0.02	0.09 ± 0.01	0.08 ± 0.01	55/52/61	0.09 ± 0.01	0.08 ± 0.01	0.04 ± 0.02	0.07 ± 0.01	0.07 ± 0.01
Formaldehyde	60/60/60	1.90 ± 0.37	2.75 ± 0.76	5.71 ± 0.80	2.26 ± 0.70	3.16 ± 0.50	60/60/60	1.51 ± 0.25	2.96 ± 0.78	4.37 ± 0.63	2.24 ± 0.33	2.72 ± 0.37
Hexachloro-1,3-butadiene	5/0/60	NR	NR	NR	NR	NR	14/0/61	0.01 ± 0.01	0.03 ± 0.02	0.01 ± 0.02	0.02 ± 0.02	0.02 ± 0.01
Arsenic (TSP)[a]	60/60/60	0.45 ± 0.10	0.57 ± 0.15	0.65 ± 0.16	0.56 ± 0.11	0.56 ± 0.07	60/60/60	0.41 ± 0.10	0.49 ± 0.10	0.59 ± 0.12	0.59 ± 0.18	0.51 ± 0.06

NA = Not available because the criteria for calculating a quarterly and/or annual average were not met.
NS = Sampling was not conducted during this time.
NR = Not reportable due to invalidation related to a contaminated internal standard.
[a] Average concentrations provided for the pollutants below the blue line are presented in ng/m³ for ease of viewing.

Table 18-3. Quarterly and Annual Average Concentrations of the Pollutants of Interest for the Oklahoma Monitoring Sites (Continued)

Pollutant	2015						2016					
	# of Detects/ # >MDL/ # Samples	Q1 Avg (µg/m³)	Q2 Avg (µg/m³)	Q3 Avg (µg/m³)	Q4 Avg (µg/m³)	Annual Average (µg/m³)	# of Detects/ # >MDL/ # Samples	Q1 Avg (µg/m³)	Q2 Avg (µg/m³)	Q3 Avg (µg/m³)	Q4 Avg (µg/m³)	Annual Average (µg/m³)
Near-road, Oklahoma City, Oklahoma - NROK												
Acetaldehyde	NS	NS	NS	NS	NS	NS	38/38/38	NS	NR	2.16 ± 0.18	1.85 ± 0.41	NR
Benzene	NS	NS	NS	NS	NS	NS	38/38/38	NS	NR	1.17 ± 0.10	0.94 ± 0.23	NR
1,3-Butadiene	NS	NS	NS	NS	NS	NS	38/36/38	NS	NR	0.17 ± 0.03	0.15 ± 0.04	NR
Carbon Tetrachloride	NS	NS	NS	NS	NS	NS	38/38/38	NS	NR	0.50 ± 0.10	0.50 ± 0.06	NR
p-Dichlorobenzene	NS	NS	NS	NS	NS	NS	32/10/38	NS	NR	0.12 ± 0.04	0.11 ± 0.05	NR
1,2-Dichloroethane	NS	NS	NS	NS	NS	NS	32/30/38	NS	NR	0.05 ± 0.02	0.07 ± 0.02	NR
Ethylbenzene	NS	NS	NS	NS	NS	NS	38/37/38	NS	NR	0.80 ± 0.07	0.37 ± 0.13	NR
Formaldehyde	NS	NS	NS	NS	NS	NS	38/38/38	NS	NR	4.80 ± 0.55	2.45 ± 0.41	NR

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Table 18-3. Quarterly and Annual Average Concentrations of the Pollutants of Interest for the Oklahoma Monitoring Sites (Continued)

Pollutant	2015						2016					
	# of Detects/ # >MDL/ # Samples	Q1 Avg (µg/m³)	Q2 Avg (µg/m³)	Q3 Avg (µg/m³)	Q4 Avg (µg/m³)	Annual Average (µg/m³)	# of Detects/ # >MDL/ # Samples	Q1 Avg (µg/m³)	Q2 Avg (µg/m³)	Q3 Avg (µg/m³)	Q4 Avg (µg/m³)	Annual Average (µg/m³)
Yukon, Oklahoma - YUOK												
Acetaldehyde	59/59/59	1.30 ± 0.34	1.64 ± 0.28	2.16 ± 0.26	1.49 ± 0.29	1.64 ± 0.16	61/61/61	1.16 ± 0.15	1.59 ± 0.27	1.93 ± 0.17	1.72 ± 0.30	1.60 ± 0.13
Benzene	59/59/59	0.65 ± 0.06	0.41 ± 0.07	0.60 ± 0.25	0.56 ± 0.04	0.56 ± 0.07	61/61/61	0.56 ± 0.10	0.41 ± 0.05	0.50 ± 0.11	0.61 ± 0.10	0.52 ± 0.05
1,3-Butadiene	51/33/59	0.04 ± 0.01	0.04 ± 0.01	0.03 ± 0.02	0.04 ± 0.02	0.04 ± 0.01	57/10/61	0.04 ± 0.01	0.04 ± 0.01	0.04 ± 0.01	0.04 ± 0.01	0.04 ± 0.01
Carbon Tetrachloride	59/59/59	0.58 ± 0.06	0.64 ± 0.03	0.67 ± 0.03	0.58 ± 0.06	0.62 ± 0.03	61/61/61	0.58 ± 0.03	0.64 ± 0.03	0.61 ± 0.03	0.60 ± 0.08	0.61 ± 0.02
1,2-Dichloroethane	57/47/59	0.09 ± 0.01	0.08 ± 0.01	0.06 ± 0.02	0.08 ± 0.01	0.08 ± 0.01	57/54/61	0.09 ± 0.01	0.09 ± 0.01	0.05 ± 0.02	0.08 ± 0.01	0.08 ± 0.01
Formaldehyde	59/59/59	1.76 ± 0.32	2.40 ± 0.54	4.57 ± 0.61	2.23 ± 0.81	2.71 ± 0.39	61/61/61	1.33 ± 0.22	2.83 ± 0.70	4.35 ± 0.50	2.13 ± 0.45	2.64 ± 0.37
Hexachloro-1,3-butadiene	2/0/59	NR	NR	NR	NR	NR	13/0/61	<0.01 ± 0.01	0.03 ± 0.02	0.01 ± 0.02	0.02 ± 0.02	0.02 ± 0.01
Arsenic (TSP) [a]	59/59/59	0.46 ± 0.14	0.51 ± 0.09	0.62 ± 0.24	0.62 ± 0.21	0.55 ± 0.09	61/61/61	0.39 ± 0.09	0.54 ± 0.20	0.67 ± 0.15	0.58 ± 0.21	0.54 ± 0.08

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NR = Not reportable due to invalidation related to a contaminated internal standard.
[a] Average concentrations provided for the pollutants below the blue line are presented in ng/m³ for ease of viewing.

Table 18-3. Quarterly and Annual Average Concentrations of the Pollutants of Interest for the Oklahoma Monitoring Sites (Continued)

Pollutant	2015						2016					
	# of Detects/ # >MDL/ # Samples	Q1 Avg (µg/m³)	Q2 Avg (µg/m³)	Q3 Avg (µg/m³)	Q4 Avg (µg/m³)	Annual Average (µg/m³)	# of Detects/ # >MDL/ # Samples	Q1 Avg (µg/m³)	Q2 Avg (µg/m³)	Q3 Avg (µg/m³)	Q4 Avg (µg/m³)	Annual Average (µg/m³)
Bradley, Oklahoma - BROK												
Acetaldehyde	40/40/40	NS	1.50 ± 0.40	6.23 ± 3.78	4.23 ± 1.61	4.06 ± 1.42	60/60/60	1.08 ± 0.18	1.73 ± 0.29	1.69 ± 0.25	1.40 ± 0.26	1.46 ± 0.14
Benzene	39/39/39	NS	NA	0.75 ± 0.14	0.85 ± 0.20	NA	59/59/59	0.73 ± 0.19	0.67 ± 0.21	0.84 ± 0.20	0.96 ± 0.26	0.80 ± 0.10
1,3-Butadiene	29/13/39	NS	NA	0.02 ± 0.01	0.02 ± 0.01	NA	45/2/59	0.02 ± 0.01	0.02 ± 0.01	0.02 ± 0.01	0.02 ± 0.01	0.02 ± <0.01
Carbon Tetrachloride	39/39/39	NS	NA	0.66 ± 0.03	0.56 ± 0.05	NA	59/59/59	0.56 ± 0.07	0.70 ± 0.03	0.57 ± 0.09	0.54 ± 0.07	0.59 ± 0.04
1,2-Dichloroethane	34/32/39	NS	NA	0.07 ± 0.02	0.08 ± 0.02	NA	56/56/59	0.10 ± 0.01	0.12 ± 0.02	0.06 ± 0.02	0.10 ± 0.01	0.09 ± 0.01
Formaldehyde	40/40/40	NS	1.81 ± 0.60	8.27 ± 3.86	4.58 ± 1.89	4.95 ± 1.59	60/60/60	1.20 ± 0.21	2.30 ± 0.50	3.36 ± 0.59	1.52 ± 0.33	2.07 ± 0.30
Propionaldehyde	40/40/40	NS	0.27 ± 0.08	1.75 ± 1.16	0.97 ± 0.38	1.01 ± 0.42	60/60/60	0.26 ± 0.05	0.42 ± 0.08	0.37 ± 0.06	0.28 ± 0.05	0.33 ± 0.03

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NS = Sampling was not conducted during this time.
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[a] Average concentrations provided for the pollutants below the blue line are presented in ng/m³ for ease of viewing.

Observations for the Tulsa sites from Table 18-4 include the following:

- The pollutants with the highest annual average concentrations for each of the Tulsa sites are formaldehyde, acetaldehyde, and benzene. Annual averages for formaldehyde and acetaldehyde are greater than 1 $\mu g/m^3$ for all three sites; TOOK's annual average concentrations for benzene are also greater than 1 $\mu g/m^3$.

- Across the Tulsa sites, annual average concentrations of formaldehyde range from 2.67 ± 0.38 $\mu g/m^3$ (TROK, 2015) to 3.33 ± 0.39 $\mu g/m^3$ (TOOK, 2016). For each site, the annual average for 2016 appears higher than the annual average for 2015, but the difference is not statistically significant. The quarterly average concentrations for TOOK, TMOK, and TROK indicate that higher concentrations were most often measured during the warmer months of the year. Thirty-nine of the 43 concentrations of formaldehyde greater than 5 $\mu g/m^3$ measured at these three sites were measured in June, July, or August of either year. In 2015, all 16 formaldehyde concentrations greater than 5 $\mu g/m^3$ were measured between June and August; for 2016, 23 of the 27 formaldehyde concentrations greater than 5 $\mu g/m^3$ were measured between June and August (with the exceptions in February and September).

- Across the Tulsa sites, annual average concentrations of acetaldehyde range from 1.77 ± 0.16 $\mu g/m^3$ (TMOK, 2016) to 2.02 ± 0.21 $\mu g/m^3$ (TOOK, 2015), although a similar average was calculated for TROK in 2016. For each site, the annual averages for 2015 and 2016 vary by 0.1 $\mu g/m^3$ or less. While the highest acetaldehyde concentrations were often measured at these sites between June and August, there is more variability during the seasons in which the higher concentrations were measured than formaldehyde.

- Across the Tulsa sites, annual average concentrations of benzene range from 0.79 ± 0.06 $\mu g/m^3$ (TROK, 2015) to 1.09 ± 0.12 $\mu g/m^3$ (TOOK, 2015). For each site, the annual averages for 2015 and 2016 vary by 0.1 $\mu g/m^3$ or less, with the annual averages for TOOK varying by 0.01 $\mu g/m^3$. Ten benzene concentrations greater than 2 $\mu g/m^3$ were measured at these three sites, with eight of the 10 measured at TOOK, and one each measured at TROK and TMOK.

- Hexachloro-1,3-butadiene is a pollutant of interest for TMOK and TROK. Quarterly and annual averages for hexachloro-1,3-butadiene for 2015 are not presented in Table 18-3 due to the use of a contaminated internal standard at the laboratory for Method TO-15, which resulted in the invalidation of the results from early March 2015 through mid-December 2015, as described in Section 2.4. TMOK and TROK's annual average concentrations of hexchloro-1,3-butadiene for 2016 are similar to each other, with the quarterly averages exhibiting slightly more variability.

- Several of the pollutants of interest exhibited little variability across the three Tulsa sites. For example, annual averages of carbon tetrachloride vary by 0.03 $\mu g/m^3$ across the three sites, though this is expected given the ubiquitous nature of this pollutant. 1,2-Dichloroethane is another example, with annual averages varying by only 0.02 $\mu g/m^3$ across these sites, as is 1,3-butadiene, with annual averages varying by only 0.04 $\mu g/m^3$.

- Arsenic is the only TSP metal that is a pollutant of interest across the three Tulsa sites. Annual average concentrations of arsenic range from 0.64 ± 0.07 ng/m^3 (TMOK, 2015) to 0.95 ± 0.20 ng/m^3 (TROK, 2016). Arsenic concentrations measured at TROK in 2016 exhibit the most variability, based on the confidence intervals shown. Three of the four quarterly average concentrations for 2016 are the same (each is 0.79 ng/m^3, though the confidence intervals vary); the fourth quarter average concentration for 2016 is considerably higher (1.43 ± 0.74 ng/m^3), with a much larger confidence interval, indicating the potential for outliers. The maximum arsenic concentration measured at TROK (5.65 ng/m^3) was measured in October 2016 and is the fourth highest arsenic concentration measured across the program. Across the Tulsa sites, six of the seven highest arsenic concentrations (those greater than 2 ng/m^3) were measured at TROK (five of which were measured in 2016).

- Concentrations of nickel measured at TOOK exhibit considerable variability, particularly for 2016. Quarterly average concentrations of nickel for TOOK range from 1.43 ± 0.34 ng/m^3 (fourth quarter, 2016) to 2.93 ± 2.84 ng/m^3 (third quarter, 2016). The maximum nickel concentration measured at TOOK (22.1 ng/m^3) is more than twice the next highest nickel concentration measured at TOOK (10.3 ng/m^3). The nine highest nickel concentrations measured across the Tulsa sites were measured at TOOK. Nickel concentrations measured at TROK, the other Tulsa site for which nickel is a pollutant of interest, exhibit less variability.

Observations for the Oklahoma City sites from Table 18-4 include the following:

- OCOK and NROK are located within Oklahoma City; YUOK is located just outside the city in nearby Yukon. Although the town of Bradley is located well outside the urban reach of Oklahoma City, Grady County is part of the Oklahoma City CBSA, and thus, BROK is included in this section.

- Sampling at BROK began in April 2015, thus first quarter averages could not be calculated for 2015. In addition, second quarter averages, and thus annual averages, for the VOCs for 2015 could not be calculated for this site. Because sampling at NROK began in May 2016, few quarterly averages and no annual averages could be calculated for this site.

- The pollutants with the highest annual average concentrations for each of the Oklahoma City sites, where they could be calculated, are formaldehyde and acetaldehyde. These are the only pollutants with annual averages greater than 1 µg/m^3, with one exception (BROK's annual average concentration of propionaldehyde for 2015).

- Across the Oklahoma City sites, annual average concentrations of formaldehyde range from 2.07 ± 0.30 µg/m^3 (BROK, 2016) to 4.95 ± 1.59 µg/m^3 (BROK, 2015). Both the highest and lowest annual averages were calculated for BROK, with the annual average for 2015 more than twice the annual average for 2016. If the annual averages for BROK are excluded, the annual averages across the remaining sites vary by about 0.5 µg/m^3. The seven highest formaldehyde concentrations measured at an Oklahoma City site were measured at BROK, each of which was measured between the end of August and mid-October 2015. For each site, the third quarter average

concentration of formaldehyde is the highest quarterly average for each year. Though the statistical significance of this varies by site, higher concentrations were most often measured during the warmer months of the year. Of the 48 concentrations of formaldehyde greater than 5 $\mu g/m^3$ measured at these sites, the majority (34) were measured during the third quarter of either year, with another seven measured in June.

- Across the Oklahoma City sites, annual average concentrations of acetaldehyde range from 1.46 ± 0.14 $\mu g/m^3$ (BROK, 2016) to 4.06 ± 1.42 $\mu g/m^3$ (BROK, 2015). Similar to formaldehyde, both the highest and lowest annual averages of acetaldehyde were calculated for BROK, with the annual average for 2015 nearly three times the annual average for 2016. If the annual averages for BROK are excluded, the annual averages across the remaining sites vary by about 0.3 $\mu g/m^3$. The 12 highest acetaldehyde concentrations measured at an Oklahoma City site were measured at BROK (those greater than 4 $\mu g/m^3$), each of which was measured between the end of August and the end of December 2015. These higher measurements are reflected in BROK's third and fourth quarter averages for 2015.

- The trend in BROK's carbonyl compound data continues with propionaldehyde. BROK's annual average concentration for 2015 is three times greater than the annual average for 2016. Among the Oklahoma City sites, propionaldehyde concentrations greater than 1 $\mu g/m^3$ were only measured at BROK. Further, the eight highest propionaldehyde concentrations measured across the program were measured at BROK.

- Among the VOC pollutants of interest, benzene and carbon tetrachloride had the highest annual average concentrations for each Oklahoma City site. Annual averages for the remaining VOC pollutants of interest are less than 0.1 $\mu g/m^3$.

- Across the Oklahoma City sites, annual average concentrations of benzene range from 0.52 ± 0.05 $\mu g/m^3$ (YUOK, 2016) to 0.80 ± 0.10 $\mu g/m^3$ (BROK, 2016). The site-specific annual average concentrations vary little across each year, where two annual averages could be calculated. Among the Oklahoma City sites, the highest benzene concentration was measured at OCOK (3.71 $\mu g/m^3$), which is reflected in this site's first quarter average concentration for 2016 (0.76 ± 0.42 $\mu g/m^3$). While the quarterly average itself is only slightly higher than the other quarterly averages, the confidence interval is four to five times higher than the confidence intervals calculated for the remaining quarterly averages. Other Oklahoma City sites have quarterly average concentrations of similar or greater magnitude (NROK, BROK), but the confidence intervals are considerably less. NROK's third quarter average concentration for 2016 (1.17 ± 0.10 $\mu g/m^3$) is the highest quarterly average concentration of benzene among the Oklahoma City sites.

- Across the Oklahoma City sites, annual average concentrations of carbon tetrachloride vary by about 0.05 $\mu g/m^3$, ranging from 0.59 ± 0.04 $\mu g/m^3$ (BROK, 2016) to 0.64 ± 0.02 $\mu g/m^3$ (OCOK, 2015). The quarterly average concentrations exhibit somewhat more variability across the sites, ranging from 0.50 ± 0.06 $\mu g/m^3$ (NROK, third quarter 2016) to 0.70 ± 0.03 $\mu g/m^3$ (BROK, second quarter 2016).

- Arsenic is a pollutant of interest for OCOK and YUOK. Annual average concentrations of arsenic for these two sites vary by only 0.05 ng/m^3, ranging from 0.51 ± 0.06 ng/m^3 (OCOK, 2016) to 0.56 ± 0.07 ng/m^3 (OCOK, 2015). The quarterly average concentrations of arsenic exhibit more variability, ranging from 0.39 ± 0.09 ng/m^3 (YUOK, first quarter 2016) to 0.67 ± 0.15 ng/m^3 (YUOK, third quarter 2016).

Tables 4-10 through 4-13 present the NMP sites with the 10 highest annual average concentrations for each of the program-level pollutants of interest. Observations for the Oklahoma sites include the following:

- The Oklahoma sites appear in Tables 4-10 through 4-13 a total of 27 times. However, because they are the only sites sampling TSP metals, each Oklahoma site appears for arsenic, accounting for 10 of the appearances.

- TOOK is the only Oklahoma site to appear in Table 4-10 for benzene; this site has the eighth (2015) and tenth (2016) highest annual average concentrations of benzene.

- TMOK is the only Oklahoma site to appear in Table 4-10 for *p*-dichlorobenzene; this site has the seventh (2016) and eighth (2015) highest annual average concentrations of *p*-dichlorobenzene.

- Four Oklahoma sites appear in Table 4-10 for their annual average concentrations of 1,2-dichloroethane; TMOK, TOOK, TROK, and BROK's 2016 annual averages rank seventh through tenth, respectively, for 1,2-dichloroethane.

- Each of the Tulsa sites appear in Table 4-10 for ethylbenzene, ranking fifth (TOOK), seventh (TMOK), and ninth (TROK) for their 2016 annual averages; TOOK's annual average concentration for 2015 ranks tenth.

- Each of the Tulsa sites appear in Table 4-10 for hexachloro-1,3-butadiene, ranking second (TMOK), third (TROK), and seventh (TOOK) for their 2016 annual averages.

- BROK is the only Oklahoma City site to appear in Table 4-10 for VOCs.

- BROK is also the only Oklahoma site that appears in Table 4-11 for the carbonyl compounds. BROK's 2015 annual average concentration of acetaldehyde ranks highest among NMP sites sampling this pollutant, and BROK's 2015 annual average concentration of formaldehyde ranks fourth. BROK's 2016 annual average concentrations of these pollutants do not appear in Table 4-11.

- Each of the Tulsa sites' annual averages of arsenic for 2015 and 2016 rank higher than the annual averages for OCOK and YUOK, as shown in Table 4-13. There is a considerable difference in the annual averages shown between the sites from the two metro areas. TROK has the highest annual average arsenic concentration among the Oklahoma sites (2016).

18.3.2 Concentration Comparison

In order to better illustrate how each site's annual average concentrations compare to the program-level averages, a site-specific box plot was created for each of the site-specific pollutants of interest, where applicable. Thus, box plots were created for the pollutants listed in Table 18-3 for the seven Oklahoma sites. Figures 18-11 through 18-23 overlay these sites' minimum, annual average, and maximum concentrations onto the program-level minimum, first quartile, median, average, third quartile, and maximum concentrations, as described in Section 3.4.2.1, and are discussed below. If an annual average concentration could not be calculated, the range of concentrations is still provided in the figures that follow.

Figure 18-11. Program vs. Site-Specific Average Acetaldehyde Concentrations

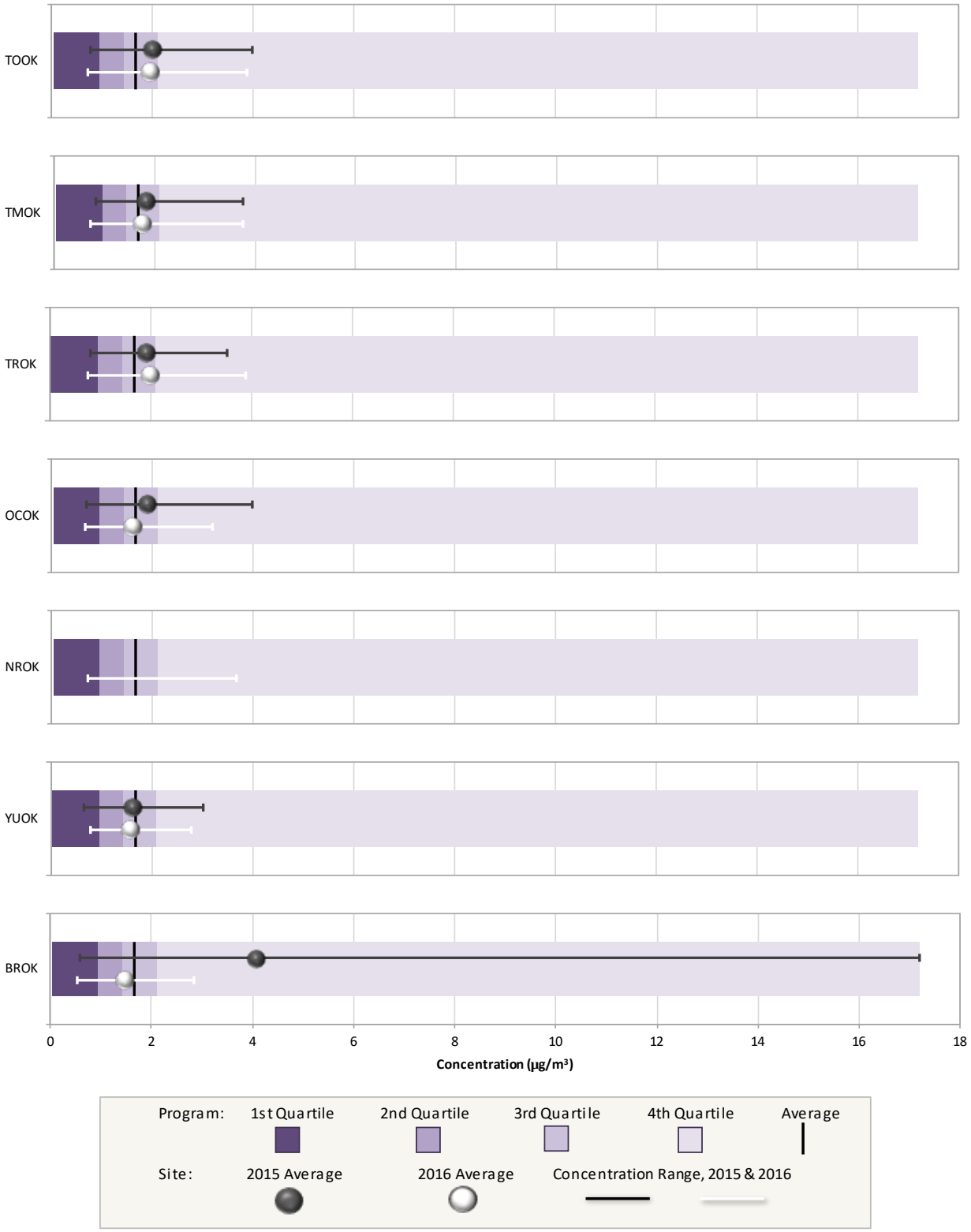


Figure 18-11 presents the box plots for acetaldehyde for all seven Oklahoma sites and shows the following:

- The maximum acetaldehyde concentration measured across the program was measured at BROK in 2015 (17.2 µg/m^3). Three of the four highest concentrations of acetaldehyde across the program were measured at BROK (17.2 µg/m^3, 17.0 µg/m^3, 16.7 µg/m^3). Acetaldehyde concentrations greater than 4 µg/m^3 were not measured at the remaining Oklahoma sites.

- The range of acetaldehyde concentrations measured at each Tulsa site is fairly similar between the two years of sampling. The ranges measured at the Oklahoma City sites are more variable.

- Both annual averages for all three Tulsa sites are greater than the program-level average concentration (1.67 µg/m^3) but less than the program-level third quartile (2.11 µg/m^3). This is also true for OCOK's annual average for 2015, while this site's annual average for 2016 is just less than the program-level average. This is also true for both of YUOK's annual averages.

- BROK has the largest difference between its annual averages. The annual average concentration of acetaldehyde for 2015 is more than twice the annual average for 2016. BROK's annual average for 2016 is similar in magnitude to the annual averages for 2016 for the other Oklahoma City sites.

Figure 18-12. Program vs. Site-Specific Average Arsenic (TSP) Concentrations

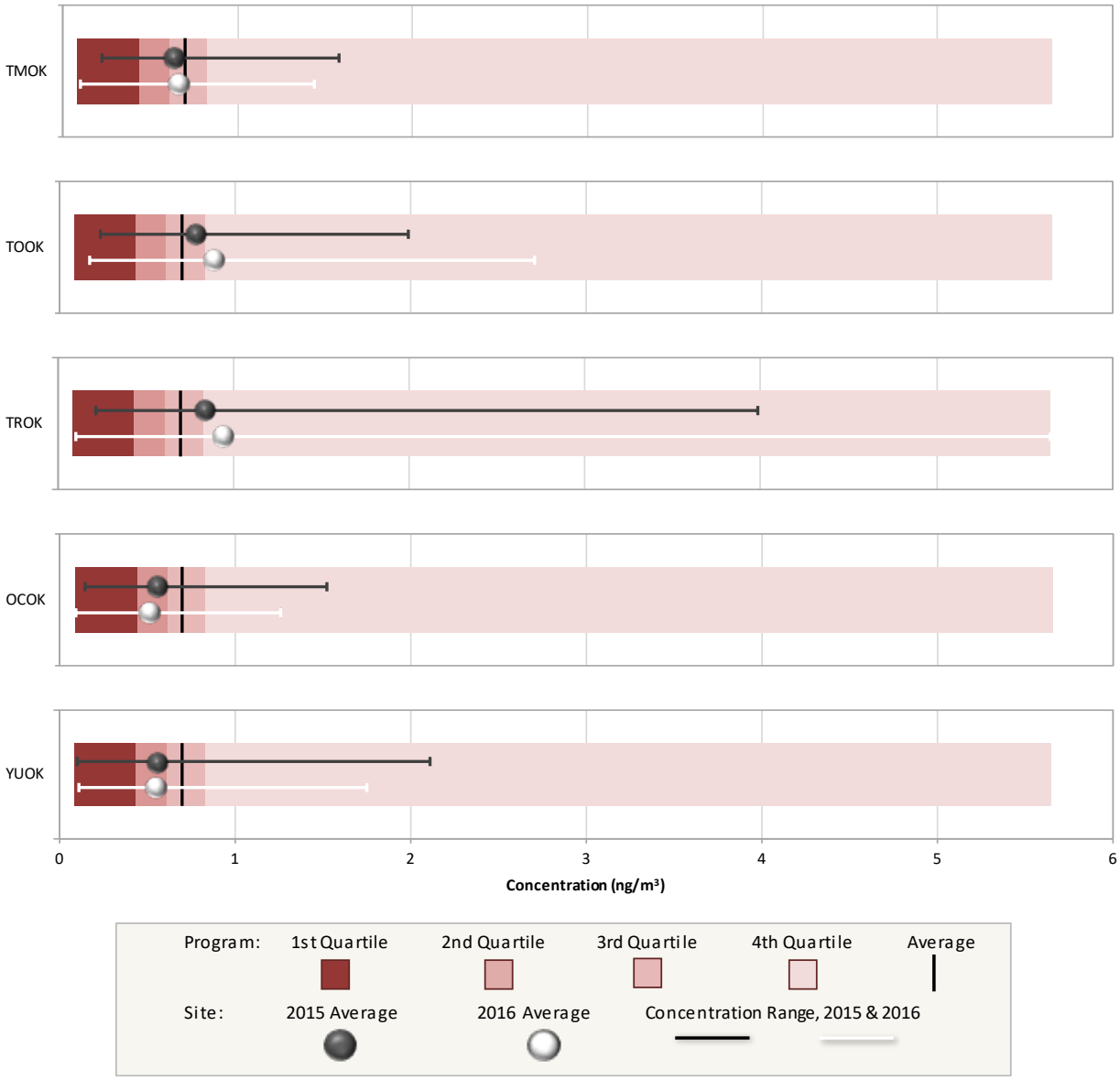


Figure 18-12 presents the box plots for arsenic for the five Oklahoma sites sampling TSP metals and shows the following:

- Because the Oklahoma sites are the only sites sampling TSP metals, Figure 18-12 compares each Oklahoma site's arsenic data against the combined Oklahoma data.

- The range of arsenic concentrations measured was smallest for OCOK and largest for TROK. For both years of sampling, the maximum concentration of arsenic was measured at TROK. Non-detects of arsenic were not measured at these sites.

- TROK and TOOK have the highest annual average concentrations of arsenic (TSP), with all four greater than the program-level/TSP average arsenic concentration (0.70 ng/m^3). TMOK's annual averages are just less than the program-level/TSP

average while OCOK and YUOK's annual averages are just less than program-level/TSP median concentration (0.61 ng/m^3).

Figure 18-13. Program vs. Site-Specific Average Benzene Concentrations

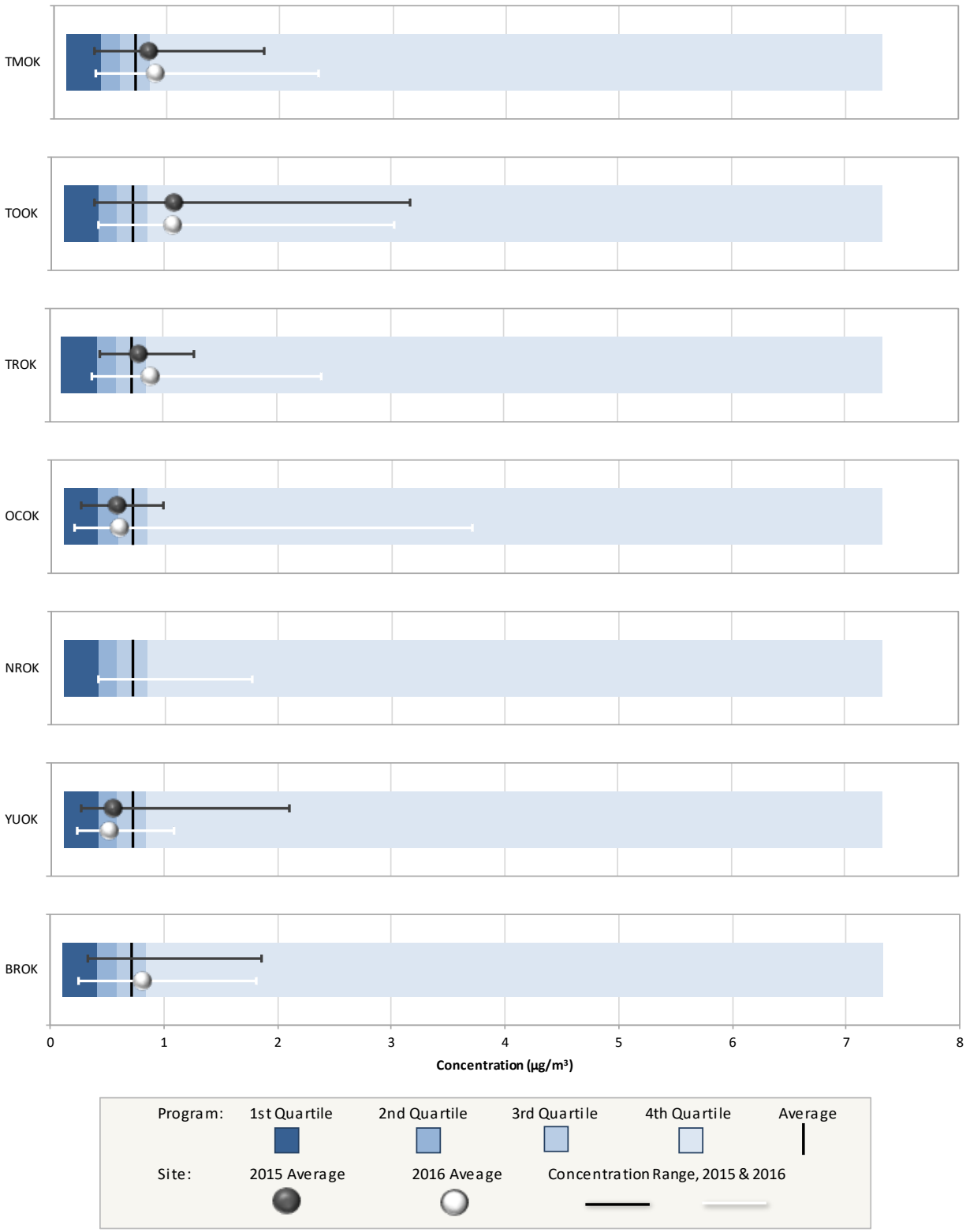


Figure 18-13 presents the box plots for benzene for all seven Oklahoma sites and shows the following:

- The maximum concentration of benzene measured at an Oklahoma site was measured at OCOK (3.71 µg/m^3), although this concentration is roughly half the maximum concentration measured across the program. If this maximum concentration was excluded from OCOK's 2016 dataset, the range of benzene concentrations measured at OCOK in 2016 would more closely resemble the range measured in 2015.

- The range of concentrations measured each year at some sites, such as OCOK and YUOK, vary considerably, while the range of concentrations measured at others, such as TOOK, do not. Yet, each site's annual averages vary by 0.1 µg/m^3 or less.

- TOOK is the only site for which annual average concentration(s) of benzene greater than 1 µg/m^3 were calculated. The annual average concentrations of benzene for TROK, TMOK, and BROK (2016 only) are less than 1 µg/m^3, but still greater than the program-level average concentration (0.72 µg/m^3). The annual averages for the remaining sites are similar to or less than the program-level median concentration (0.58 µg/m^3).

Figure 18-14. Program vs. Site-Specific Average 1,3-Butadiene Concentrations

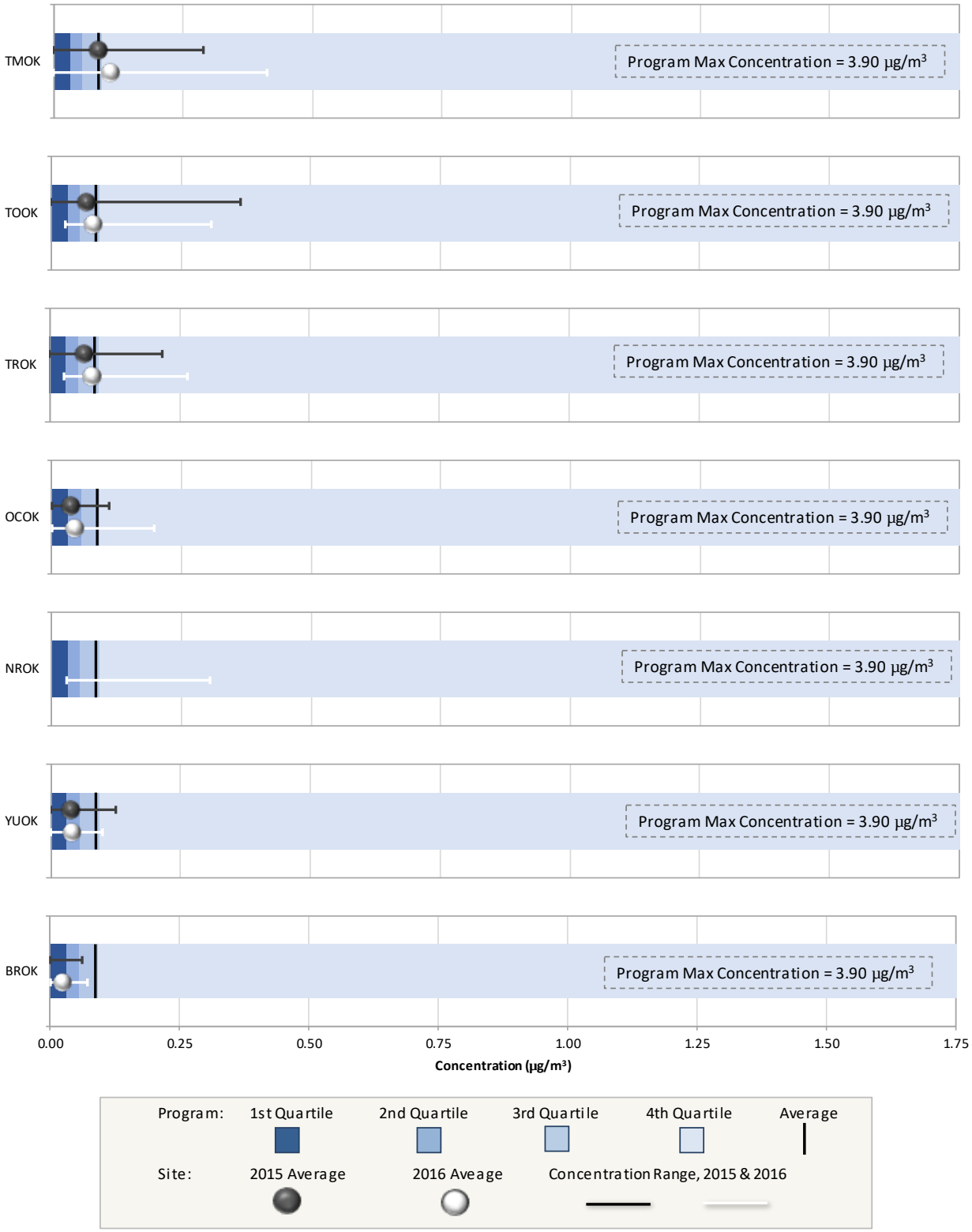


Figure 18-14 presents the box plot for 1,3-butadiene for all seven Oklahoma sites and shows the following:

- The program-level maximum 1,3-butadiene concentration (3.90 µg/m^3) is not shown directly on the box plots in Figure 18-14 because the scale of the box plots would be too large to readily observe data points at the lower end of the concentration range. Thus, the scale of the box plots has been reduced. Note that the program-level average concentration is just less than the program-level third quartile, such that they are difficult to discern in Figure 18-14.

- Concentrations of 1,3-butadiene measured at the Oklahoma sites are considerably less than the maximum concentration measured at the program-level, as all concentrations measured at these sites are less than 0.50 µg/m^3.

- The range of 1,3-butadiene concentrations measured is larger for the Tulsa sites than the Oklahoma City sites, with the exception of NROK.

- TMOK is the only Oklahoma site for which an annual average concentration of 1,3-butadine greater than the program-level average (0.09 µg/m^3) was calculated (2016 only). The annual averages for the remaining sites are similar to or less than the program-level average. The annual averages for the Oklahoma City sites, where they would be calculated, are all less than the program-level median concentration. BROK's annual average for 2016 is less than the program-level first quartile.

Figure 18-15. Program vs. Site-Specific Average Carbon Tetrachloride Concentrations

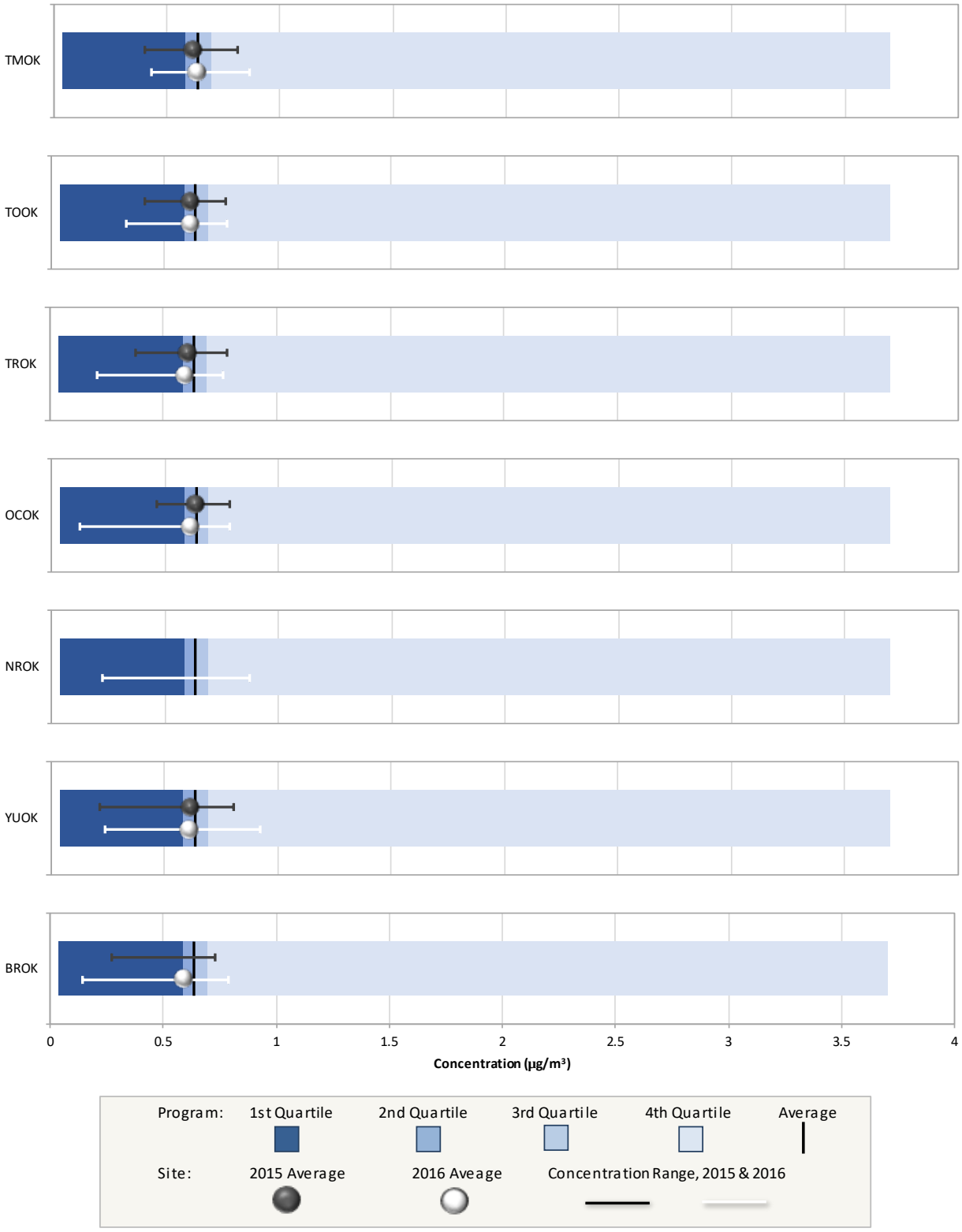


Figure 18-15 presents the box plots for carbon tetrachloride for all seven Oklahoma sites and shows the following:

- The program-level median and average concentrations are similar and plotted nearly on top of each other.
- The maximum carbon tetrachloride concentrations measured at each site are fairly similar to each other, while the minimum concentrations exhibited more variability. Carbon tetrachloride concentrations greater than 1 µg/m^3 were not measured at the Oklahoma sites.
- The annual average concentrations for these sites vary 0.05 µg/m^3 across these sites, all of which are similar to or just less than the program level average concentration of 0.64 µg/m^3.

Figure 18-16. Program vs. Site-Specific Average *p*-Dichlorobenzene Concentrations

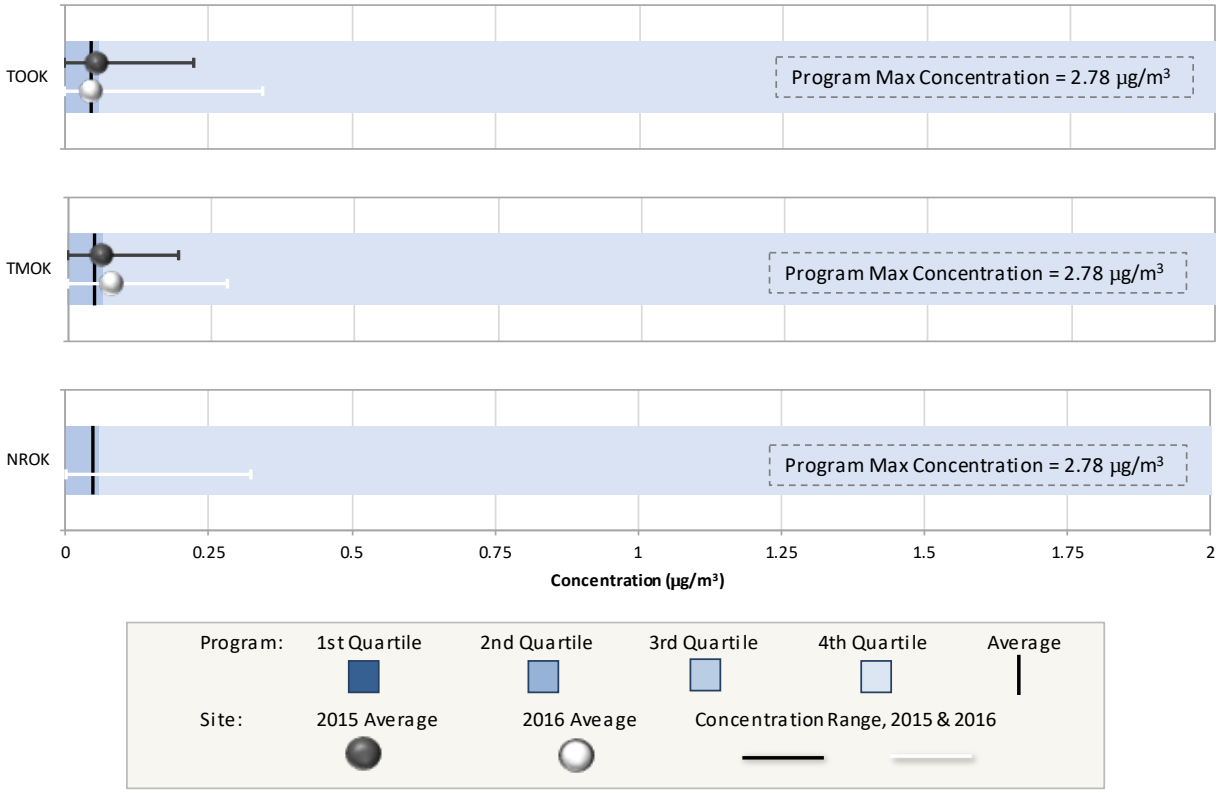


Figure 18-16 presents the box plots for *p*-dichlorobenzene for TOOK, TMOK, and NROK, and shows the following:

- Similar to 1,3-butadiene, the program-level maximum *p*-dichlorobenzene concentration (2.78 µg/m^3) is not shown directly on the box plots in Figure 18-16 because the scale of the box plots would be too large to readily observe data points at the lower end of the concentration range. Thus, the scale of the box plots has also been reduced. Note that the program-level first and second quartiles are both zero and therefore not visible on the box plots.

- *p*-Dichlorobenzene is a pollutant of interest for only three Oklahoma sites.

- All *p*-dichlorobenzene concentrations measured at these sites are less than 0.35 µg/m^3, an order of magnitude less than the maximum concentration measured across the program.

- The range of *p*-dichlorobenzene concentrations measured at each site in 2016 are similar to each other. The range of concentrations for each site in 2015 are also similar to each other, although NROK was not sampling in 2015.

- The annual average *p*-dichlorobenzene concentrations for TOOK and TMOK are similar to or greater than the program-level average concentration (0.05 µg/m^3), with TMOK's 2016 annual average also greater than the program-level third quartile (0.06 µg/m^3).

- The total number of non-detects measured at TMOK (37) is just slightly less than the number measured at TOOK (41). For TMOK, these non-detects were spread across the two years of sampling, while the majority were measured in 2016 (30 of the 41) for TOOK.

Figure 18-17. Program vs. Site-Specific Average 1,2-Dichloroethane Concentrations

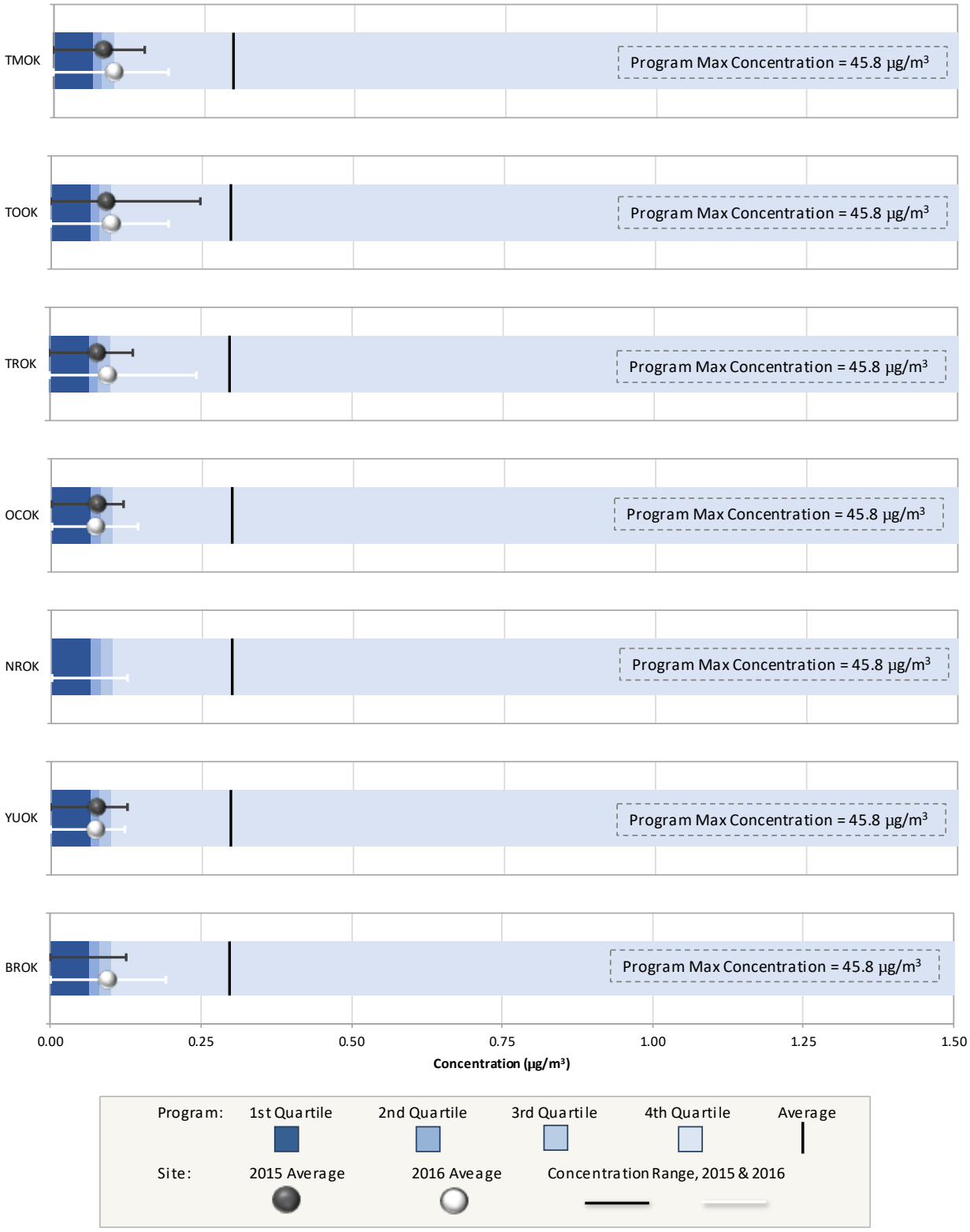


Figure 18-17 presents the box plots for 1,2-dichloroethane for all seven Oklahoma sites and shows the following:

- The scale of the box plots in Figure 18-17 has also been reduced to allow for the observation of data points at the lower end of the concentration range, as the program-level maximum 1,2-dichloroethane concentration (45.8 µg/m^3) is considerably greater than the majority of measurements.

- The program-level average concentration of 1,2-dichloroethane is being driven by the higher concentrations measured at a few monitoring sites. The entire range of 1,2-dichloroethane concentrations measured at the Oklahoma sites is less than the average concentration across the program.

- The annual average concentrations of 1,2-dichloroethane for the Oklahoma sites fall on either side of the program-level median concentration (0.08 µg/m^3), with less than 0.03 µg/m^3 separating these sites' annual averages.

Figure 18-18. Program vs. Site-Specific Average Ethylbenzene Concentrations

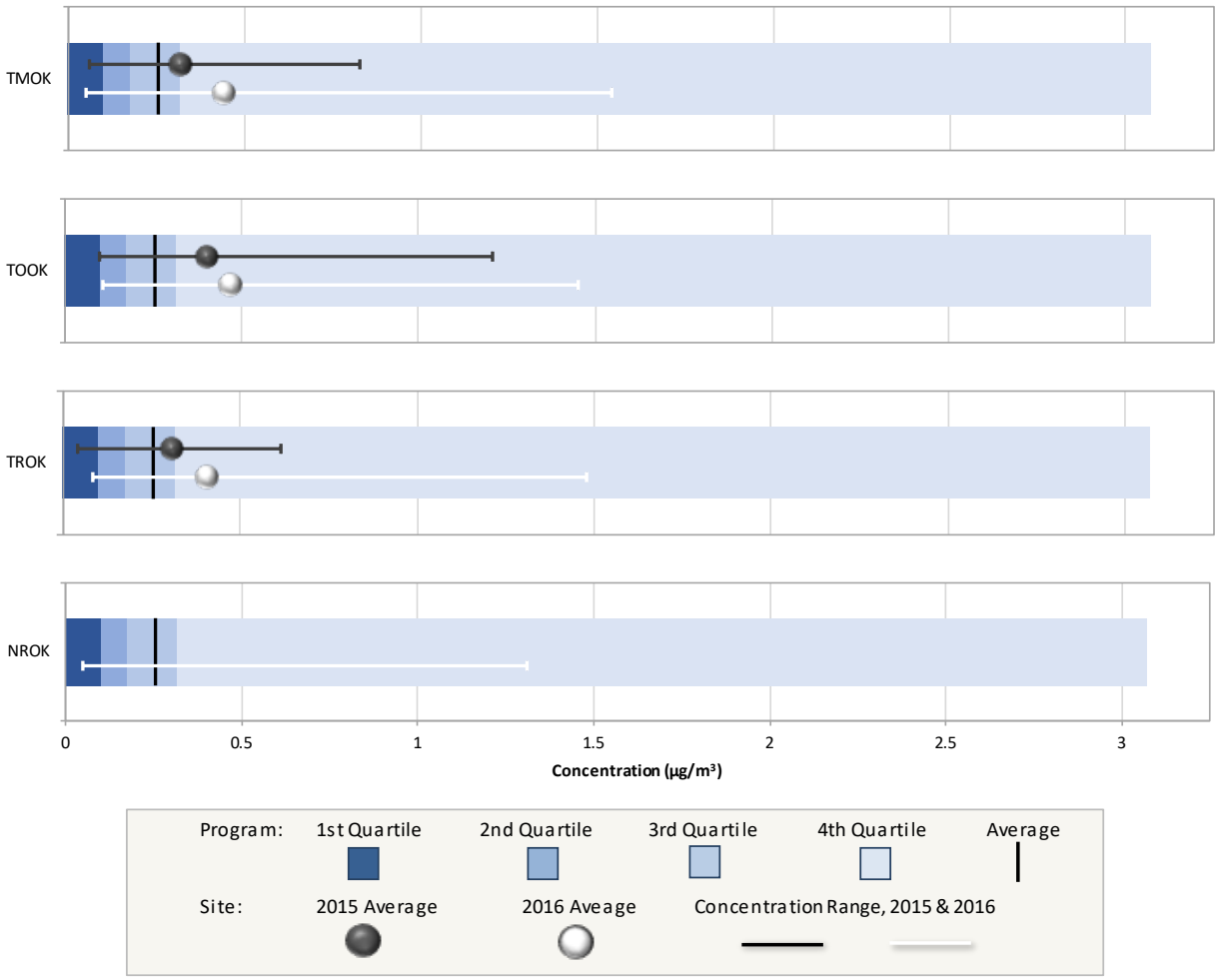


Figure 18-18 presents the box plots for ethylbenzene for TOOK, TMOK, TROK, and NROK, and shows the following:

- Ethylbenzene is a pollutant of interest for the three Tulsa sites and NROK.
- The range of ethylbenzene concentrations measured across both years is largest for TMOK and smallest for NROK. For each Tulsa site, the range of ethylbenzene concentrations measured in 2016 is larger than the range of concentrations measured in 2015.
- Each of the annual average concentrations for the Tulsa sites are greater than the program-level average concentration (0.26 µg/m^3) and most are also greater than the program-level third quartile (0.32 µg/m^3).
- Non-detects of ethylbenzene were not measured at these four sites. The minimum concentration measured at TOOK in 2015 is equivalent to the program-level first quartile (0.10 µg/m^3); the minimum concentration measured in 2016 is similar in magnitude.

Figure 18-19. Program vs. Site-Specific Average Formaldehyde Concentrations

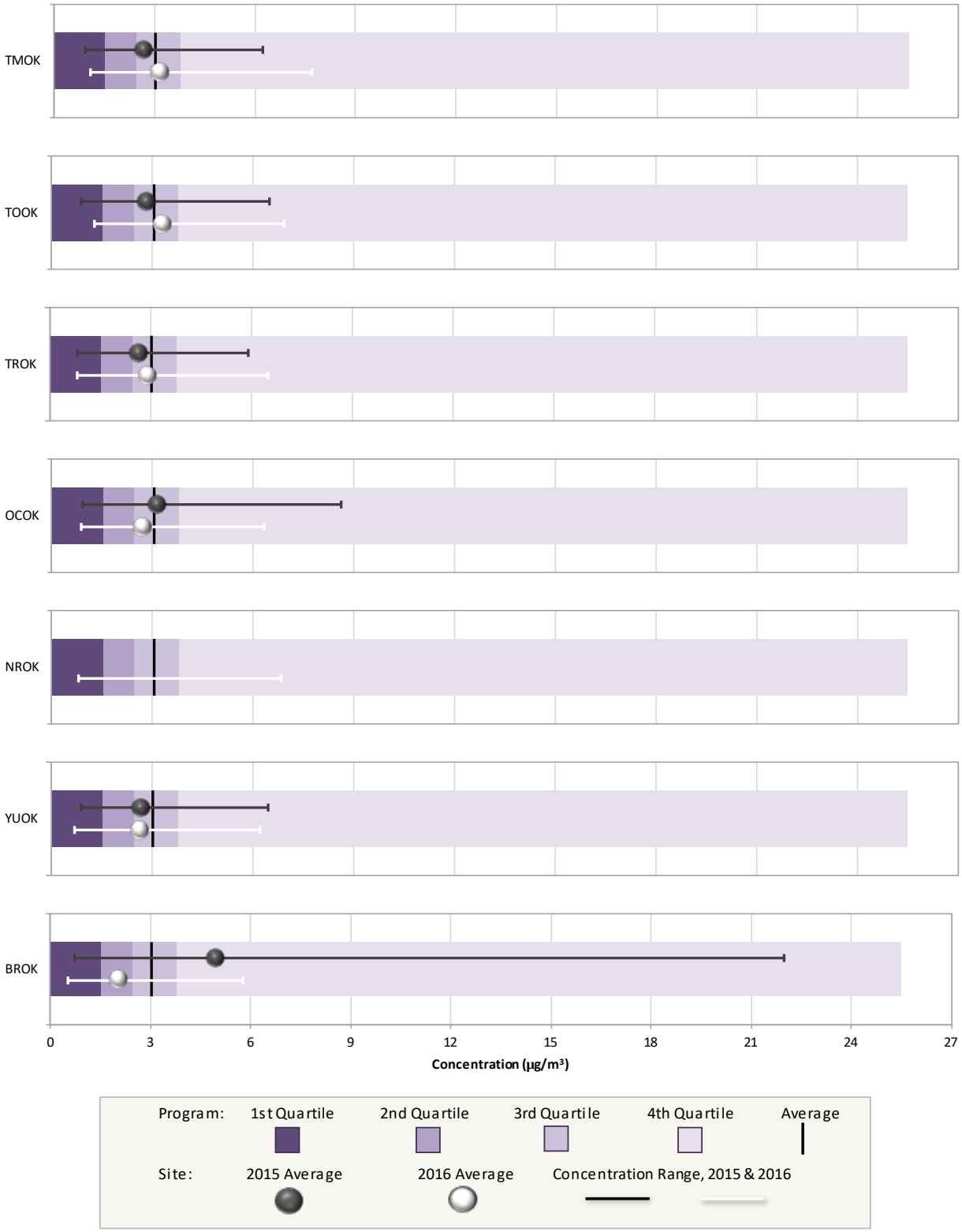


Figure 18-19 presents the box plots for formaldehyde for all seven Oklahoma sites and shows the following:

- The maximum formaldehyde concentration measured at BROK is among the highest formaldehyde concentrations measured across the program. Seven formaldehyde concentrations measured at BROK are greater than the highest formaldehyde concentration measured at another Oklahoma site. BROK's annual average concentration for 2015 is just less than the maximum formaldehyde concentration measured at this site in 2016.

- If BROK is excluded, the range of formaldehyde concentrations measured at OCOK exhibit the largest difference between the two years of sampling.

- With the exception of BROK, the annual average concentrations of formaldehyde for each Oklahoma site fall on either side of the program-level average concentration (3.05 µg/m^3). BROK is the only site for which an annual average concentration does not fall between the program-level second (median) and third quartiles.

Figure 18-20. Program vs. Site-Specific Average Hexachloro-1,3-butadiene Concentrations

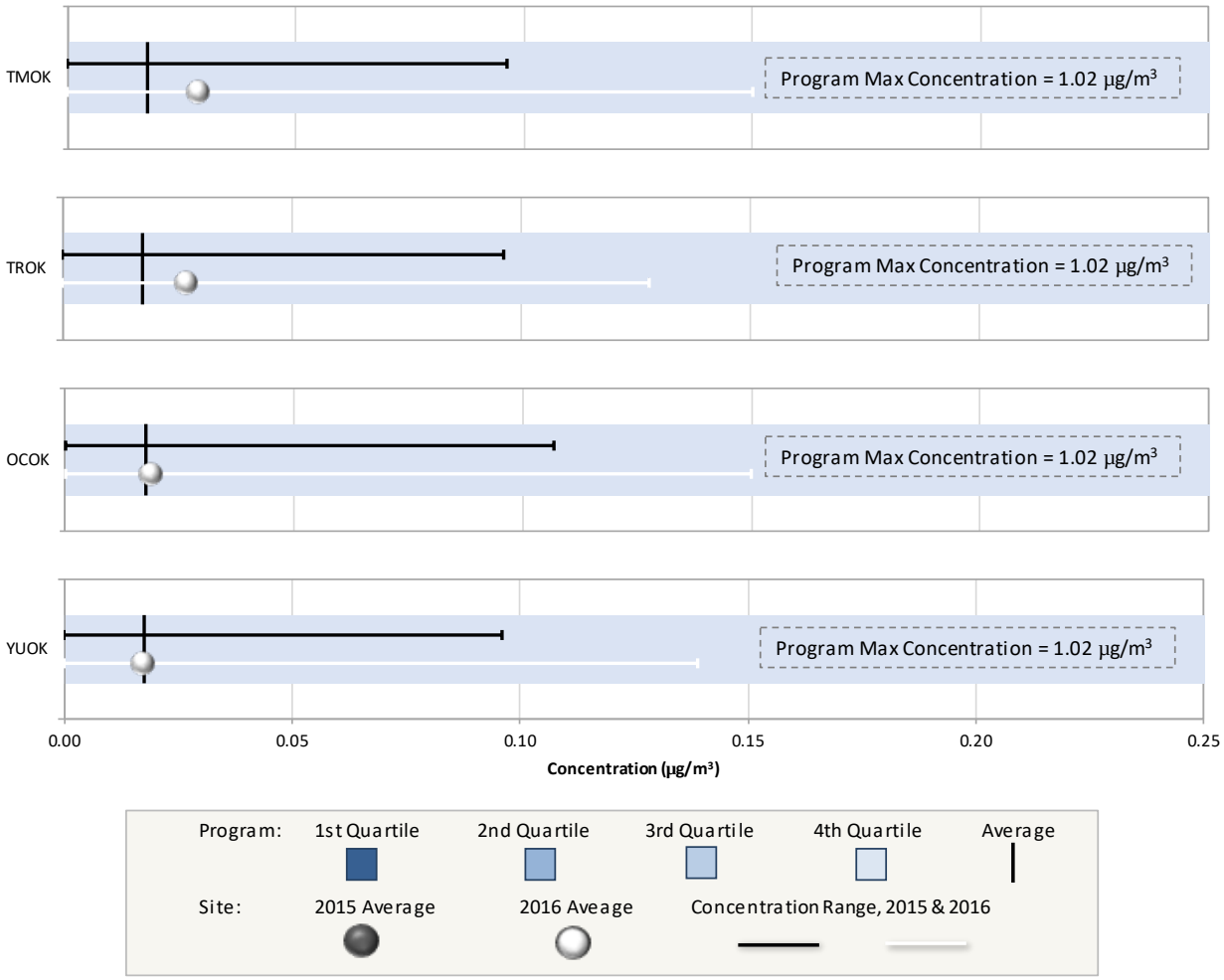


Figure 18-20 presents the box plots for hexachloro-1,3-butadiene for four of the seven Oklahoma sites and shows the following:

- The program-level maximum concentration of hexachloro-1,3-butadiene (1.02 µg/m^3) is not shown directly on the box plot as the scale has been reduced to 0.25 µg/m^3 to allow for the observations data points at the lower end of the concentration range.

- The program-level first, second, and third quartiles are all zero for this pollutant, indicating that at least 75 percent of the measurements across the program are non-detects and thus, are not visible on the box plot.

- Annual average concentrations for hexachloro-1,3-butadiene were not calculated for 2015 due to the use of a contaminated internal standard at the laboratory for Method TO-15, which resulted in the invalidation of the results from early March 2015 through mid-December 2015, as described above and in Section 2.4.

- The maximum concentration of hexachloro-1,3-butadiene for each Oklahoma site is 0.15 µg/m^3 or less. For each site, non-detects make up the majority of concentrations measured at these sites.

- The 2016 annual average concentrations of hexachloro-1,3-butadiene for TMOK and TROK are slightly greater than the program-level average concentration, while the annual averages for OCOK and YUOK are more similar to the program-level average. Less than 0.015 µg/m^3 separates these annual averages.

Figure 18-21. Program vs. Site-Specific Average Manganese (TSP) Concentrations

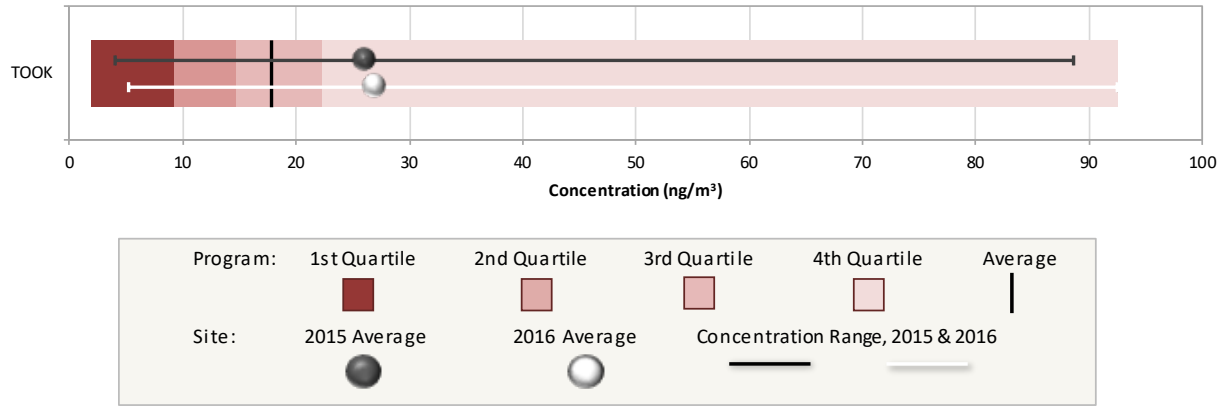


Figure 18-21 presents the box plot for manganese for TOOK and shows the following:

- TOOK is the only Oklahoma site for which manganese is a pollutant of interest. Because the Oklahoma sites are the only sites sampling TSP metals, Figure 18-21 compares the manganese concentrations measured at TOOK against the combined Oklahoma data.

- The maximum manganese concentrations measured each year at TOOK are the highest manganese concentrations measured among the Oklahoma sites.

- TOOK's annual average manganese concentration for 2015 is similar to the annual average for 2016, varying by less than 1 ng/m^3.

- TOOK's annual averages are greater than the program-level/TSP manganese concentration and third quartile (TSP only). Similar observations were made in the 2013 and 2014 NMP reports.

Figure 18-22. Program vs. Site-Specific Average Nickel (TSP) Concentrations

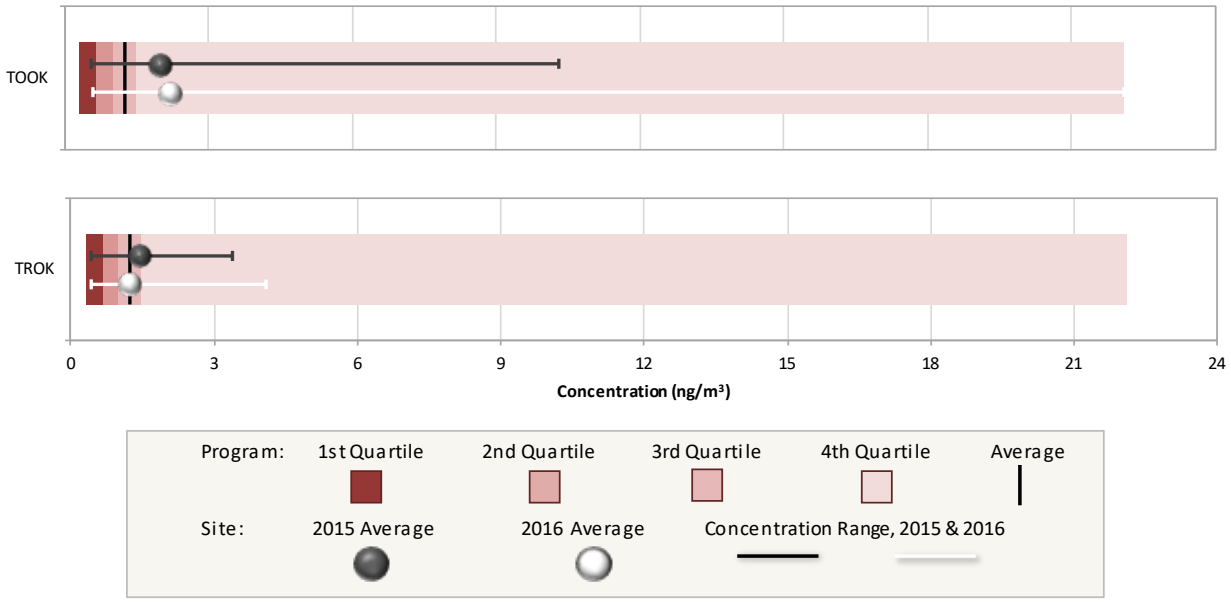


Figure 18-22 presents the box plots for nickel for TOOK and TROK and shows the following:

- TOOK and TROK are the two Oklahoma sites for which nickel is a pollutant of interest. Because the Oklahoma sites are the only sites sampling TSP metals, Figure 18-22 compares the nickel concentrations measured at TOOK and TROK against the combined Oklahoma data. Note that the majority of concentrations measured at the Oklahoma sites fall into a more compressed range for nickel than for manganese, as indicated by the closeness of the first, second, and third quartiles in the box plots.

- The maximum nickel concentration measured among the Oklahoma sites was measured at TOOK (22.1 ng/m^3). The next highest concentration measured at TOOK is half the magnitude (10.3 ng/m^3). Nine nickel concentrations measured at TOOK are greater than the highest nickel concentration measured at TROK.

- Both annual average nickel concentrations for TOOK are greater than the program-level/TSP average concentration (1.25 ng/m^3) and the third quartile (1.49 ng/m^3), TSP only. TROK's annual averages are lower.

Figure 18-23. Program vs. Site-Specific Average Propionaldehyde Concentrations

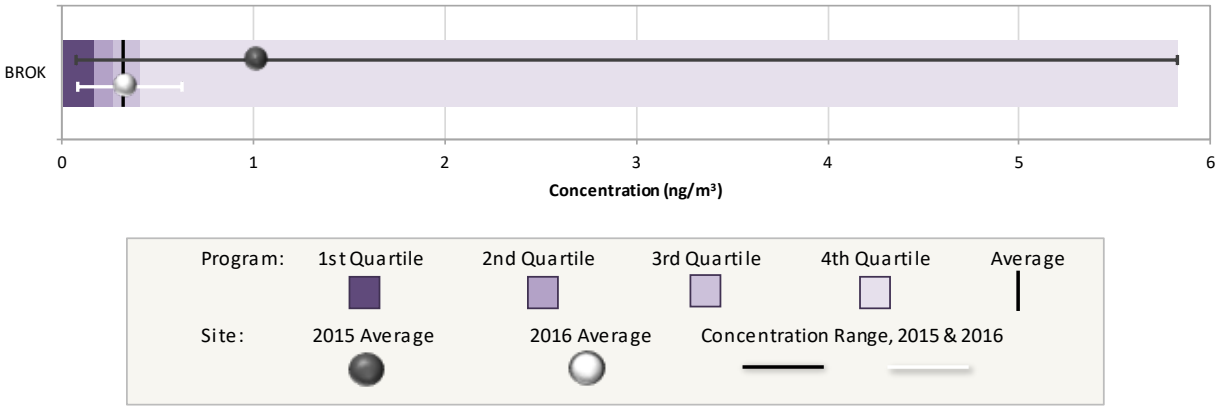


Figure 18-23 presents the box plot for propionaldehyde for BROK and shows the following:

- BROK is the only Oklahoma site with propionaldehyde as a pollutant of interest; BROK is one of only two NMP sites with propionaldehyde as a pollutant of interest (BTUT is the other).

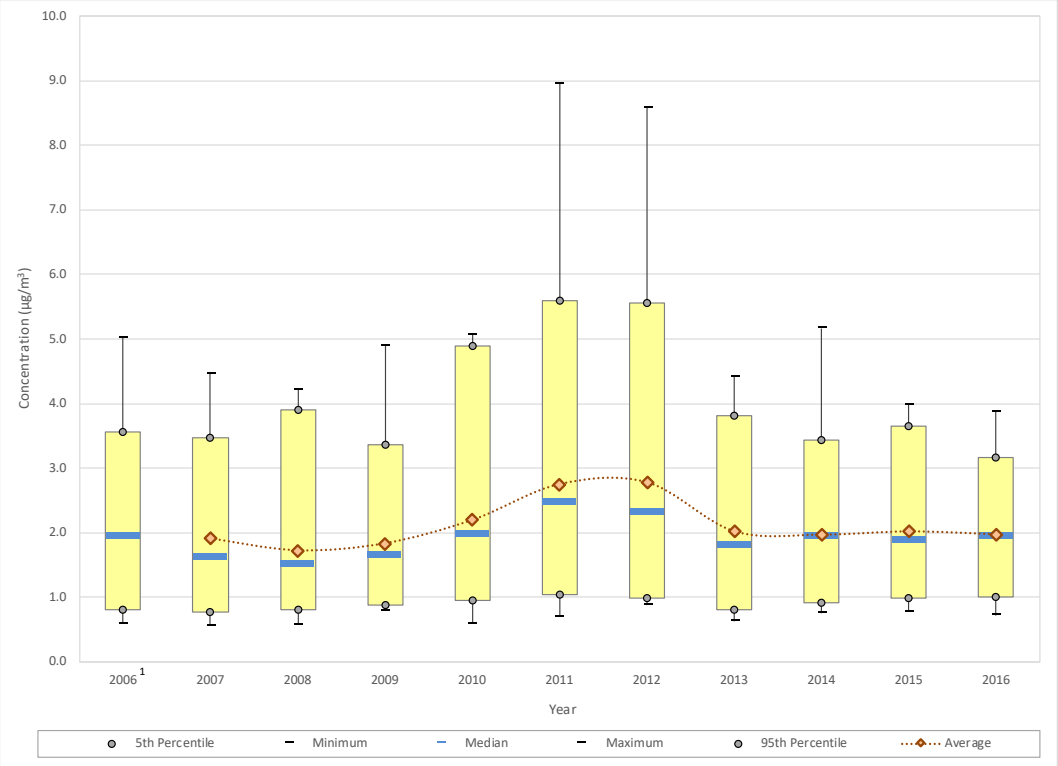
- The maximum propionaldehyde concentration (5.83 µg/m^3) measured across the program was measured at BROK in 2015; further, the eight highest propionaldehyde concentrations measured across the program were measured at BROK in 2015. Fourteen propionaldehyde concentrations measured at BROK in 2015 are greater than the maximum concentration measured at this site in 2016.

- BROK's annual average concentration for 2015 is three times greater than the annual average for 2016, which is similar in magnitude to the program-level average concentration (0.32 µg/m^3).

18.3.3 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the pollutants of interest for 5 consecutive years or longer, as described in Section 3.4.2.2. TOOK has sampled TSP metals, carbonyl compounds, and VOCs under the NMP since 2006 and TMOK and OCOK have sampled these pollutants since 2009. Thus, Figures 18-24 through 18-52 present the 1-year statistical metrics for each of the pollutants of interest first for TOOK, followed by TMOK and OCOK. The statistical metrics presented for assessing trends include the substitution of zeros for non-detects. If sampling began mid-year, a minimum of 6 months of sampling is required for inclusion in the trends analysis; in these cases, a 1-year average concentration is not provided, although the range and percentiles are still presented.

Figure 18-24. Yearly Statistical Metrics for Acetaldehyde Concentrations Measured at TOOK



[1] A 1-year average is not presented because issues at the onset of sampling resulted in low completeness.

Observations from Figure 18-24 for acetaldehyde concentrations measured at TOOK include the following:

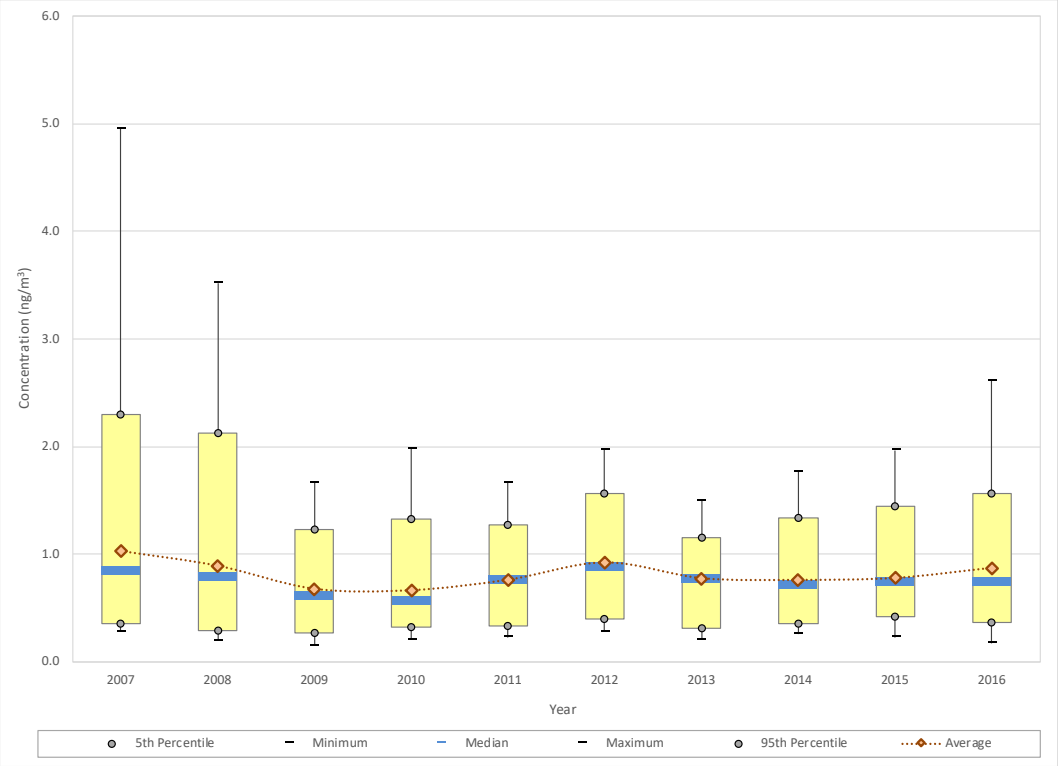
- Although TOOK began sampling carbonyl compounds under the NMP in January 2006, equipment complications at the onset of sampling resulted in a low completeness for 2006; thus, a 1-year average concentration is not presented for 2006, although the range of measurements is provided.

- The maximum concentration of acetaldehyde was measured in 2011 (8.95 µg/m^3), although a similar concentration was also measured in 2012 (8.59 µg/m^3). The 10 highest acetaldehyde concentrations were measured in 2011 or 2012. Of the 35 acetaldehyde concentrations greater than 4 µg/m^3 measured at TOOK, 20 were measured in either 2011 or 2012, five were measured in 2010, and three or fewer were measured in each of the other years (including none in 2015 and 2016).

- The statistical metrics exhibit an increasing trend between 2008 and 2011, with little change shown in the acetaldehyde measurements from 2011 to 2012. The 95th percentiles for 2011 and 2012 are greater than the maximum concentrations measured prior to 2011. These are the only two years that the median acetaldehyde concentration is greater than 2 µg/m^3.

- A significant decrease in acetaldehyde concentrations is shown for 2013, with relatively little change in the central tendency shown for 2014 through 2016.

Figure 18-25. Yearly Statistical Metrics for Arsenic (TSP) Concentrations Measured at TOOK



Observations from Figure 18-25 for arsenic (TSP) concentrations measured at TOOK include the following:

- Although TOOK began sampling TSP metals in 2006, sampling did not begin until October, which does not yield enough samples for the statistical metrics to be calculated; thus, Figure 18-25 excludes data from 2006 per the criteria specified in Section 3.4.2.2.

- The two highest concentrations of arsenic were measured at TOOK in September 2007 and are the only two concentrations greater than 4 ng/m^3 measured at TOOK. Eight of the nine concentrations of arsenic greater than 2 ng/m^3 were measured in either 2007 or 2008, with the ninth measured in 2016.

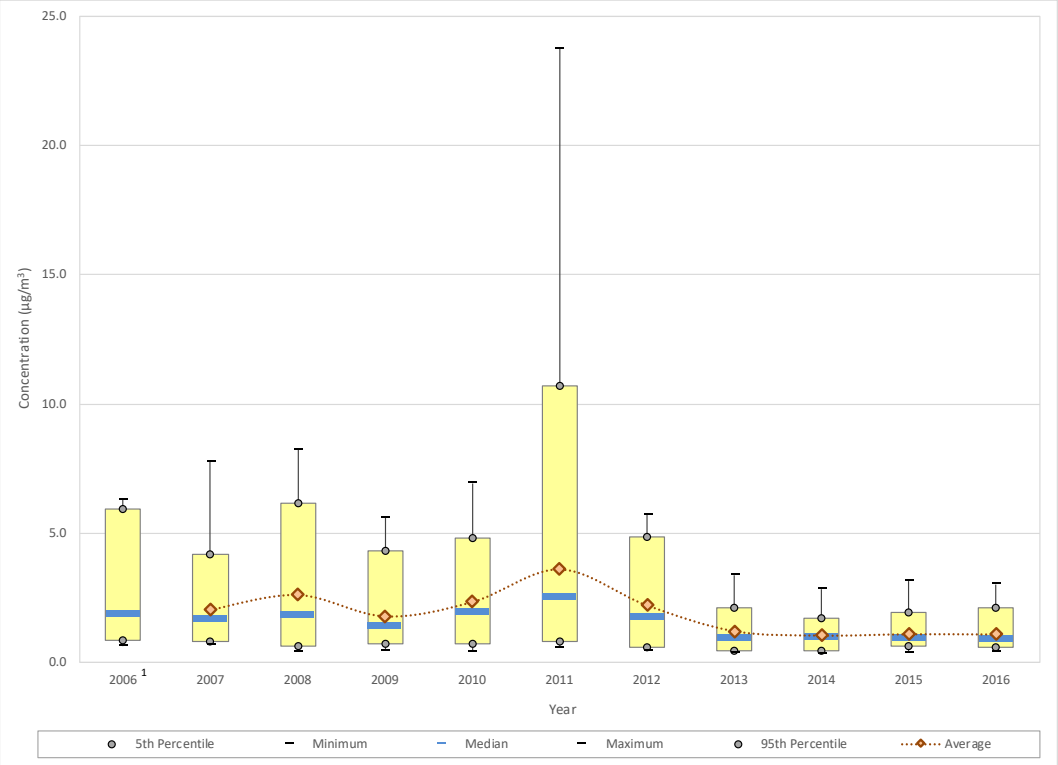
- The 1-year average and median concentrations exhibit a decreasing trend between 2007 and 2010, although the difference is relatively small between 2009 and 2010. The 1-year average and median concentrations exhibit an increasing trend between 2010 and 2012.

- All of the statistical parameters exhibit decreases from 2012 to 2013. Little change is shown in the central tendency parameters between 2013 and 2015 despite increasingly higher concentrations measured each year.

- Although the median concentration changed little from 2015 to 2016, the 1-year average concentration exhibits an increase. The range of arsenic concentrations

measured at TOOK expands again in 2016, at both ends of the concentration range. The number of arsenic concentrations greater than 1.5 ng/m^3 increased to six for 2016, including the first arsenic concentration greater than 2 ng/m^3 measured since 2008.

Figure 18-26. Yearly Statistical Metrics for Benzene Concentrations Measured at TOOK



[1] A 1-year average is not presented because issues at the onset of sampling resulted in low completeness.

Observations from Figure 18-26 for benzene concentrations measured at TOOK include the following:

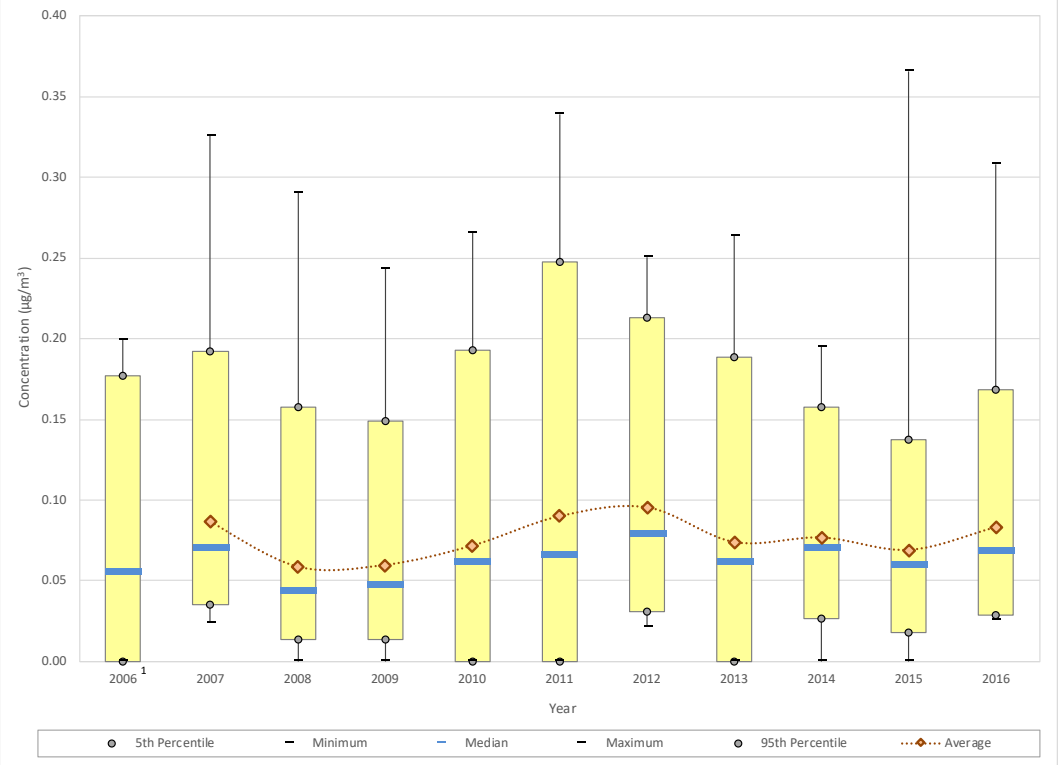
- Although TOOK began sampling VOCs under the NMP in January 2006, equipment complications at the onset of sampling resulted in a low completeness for 2006; thus, a 1-year average concentration is not presented for 2006, although the range of measurements is provided.

- The maximum concentration of benzene was measured at TOOK in 2011 (23.8 µg/m^3). All four benzene concentrations greater than 10 µg/m^3 were measured at TOOK in 2011. The 95th percentile for 2011 is greater than the maximum concentration for each of the other years shown.

- The slight increases in the statistical parameters from 2007 to 2008 are followed by significant decreases from 2008 to 2009. An increasing trend occurred between 2009 through 2011, when most of the statistical parameters are at a maximum. After 2011, a significant decreasing trend in benzene concentrations is shown, with little change shown for the most recent years of sampling. Most of the statistical parameters are at a minimum for 2014, when the smallest range of benzene concentrations was

measured, though little difference in shown among the concentration profiles for 2014, 2015, and 2016.

Figure 18-27. Yearly Statistical Metrics for 1,3-Butadiene Concentrations Measured at TOOK



[1] A 1-year average is not presented because issues at the onset of sampling resulted in low completeness.

Observations from Figure 18-27 for 1,3-butadiene concentrations measured at TOOK include the following:

- The maximum concentration of 1,3-butadiene was measured in 2015 (0.366 µg/m^3), although concentrations of similar magnitude were also measured in 2011 (0.339 µg/m^3) and 2007 (0.326 µg/m^3).

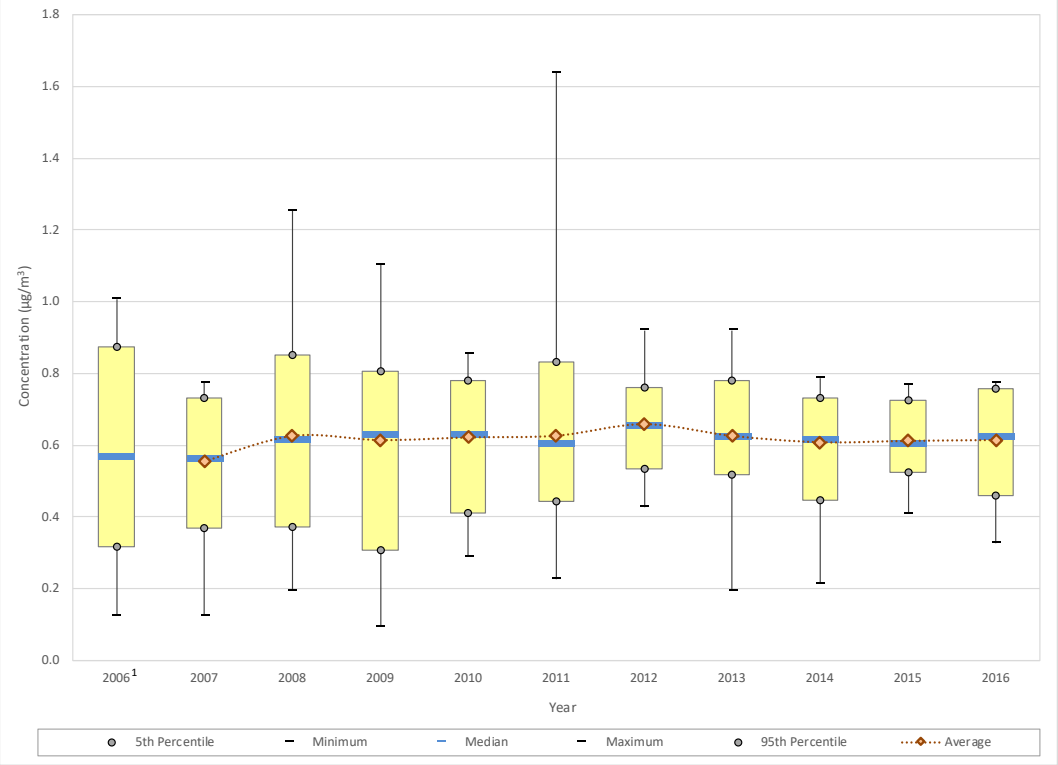
- The minimum concentration for most years is zero, indicating the presence of non-detects. For 2006, 2010, 2011, and 2013, both the minimum concentration and 5th percentile are zero, indicating that more than one non-detect was measured during those years. The percentage of non-detects has ranged from zero (2007, 2012, 2015, and 2016) to 14 percent (2006).

- After an initial decrease from 2007 to 2008 and little change for 2009, the 1-year average concentration of 1,3-butadiene has an increasing trend through 2012. This is also true for the median concentration. Even though the maximum and 95th percentile decreased for 2012, both the 1-year average and median concentrations are at a maximum.

- With the exception of the maximum concentration, all of the statistical parameters exhibit decreases for 2013. While some of this decrease is attributable to the non-detects measured, they are not the sole reason. For example, the number of 1,3-butadiene concentrations greater than 0.1 µg/m^3 decreased from 19 measured at TOOK in 2012 to 12 in 2013.

- Considerable fluctuations in 1,3-butadiene concentrations are shown for the last several years of sampling, when both the smallest (2014) and largest (2015) range of concentrations was measured. Between 2013 and 2016, less than 0.015 µg/m^3 separates the 1-year average concentrations; this is also true for the median concentrations.

Figure 18-28. Yearly Statistical Metrics for Carbon Tetrachloride Concentrations Measured at TOOK



[1] A 1-year average is not presented because issues at the onset of sampling resulted in low completeness.

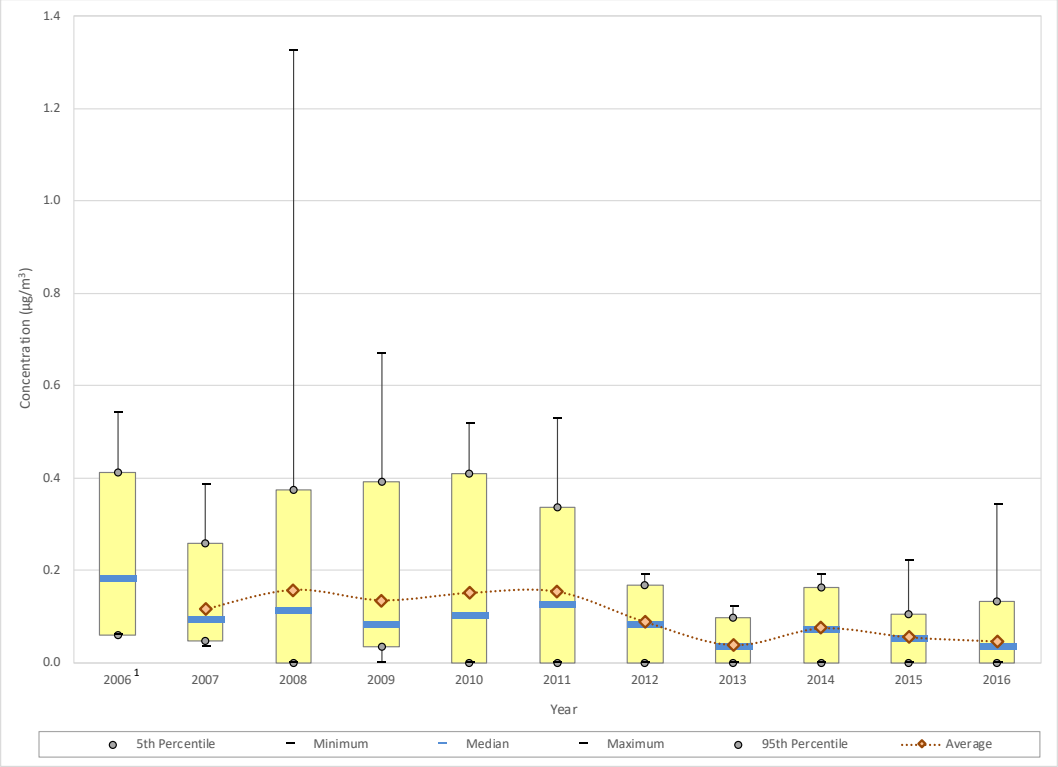
Observations from Figure 18-28 for carbon tetrachloride concentrations measured at TOOK include the following:

- The maximum concentration of carbon tetrachloride was measured in 2011 (1.64 µg/m^3). Four additional concentrations greater than 1 µg/m^3 have been measured at TOOK.

- With the exception of 2011, the range of carbon tetrachloride measurements spans approximately 1 µg/m^3 or less. The range of measurements is at a minimum for 2015, when the difference between the minimum and maximum concentrations is less than 0.4 µg/m^3.

- The 1-year average concentration increased from 2007 to 2008, after which little change is shown through 2011. A slight increase is shown for 2012, even though the concentrations span the smallest range up to this point. After 2012, the 1-year average concentration of carbon tetrachloride returned to previous levels. Excluding 2007 and 2012, the 1-year average concentrations vary from 0.61 µg/m^3 to 0.63 µg/m^3. Across all years of sampling, the 1-year average (and median concentrations) have varied by only 0.11 µg/m^3.

Figure 18-29. Yearly Statistical Metrics for *p*-Dichlorobenzene Concentrations Measured at TOOK



[1] A 1-year average is not presented because issues at the onset of sampling resulted in low completeness.

Observations from Figure 18-29 for *p*-dichlorobenzene concentrations measured at TOOK include the following:

- The maximum *p*-dichlorobenzene concentration was measured at TOOK on October 9, 2008 (1.33 µg/m^3) and is twice the next highest concentration (0.669 µg/m^3, measured in 2009). Four additional *p*-dichlorobenzene concentrations greater than 0.5 µg/m^3 have been measured at TOOK.

- The increase in the 1-year average concentration from 2007 to 2008 is not solely a result of the outlier concentration measured in 2008. The range within which the majority of concentrations lie expanded, nearly doubling from 2007 to 2008, with additional concentrations measured at the both ends of the concentration range.

- Between 2008 and 2011, most of the concentrations measured at TOOK fell into a similar range and the 1-year average concentration did not vary significantly (although there is a little more variability in the median concentrations).

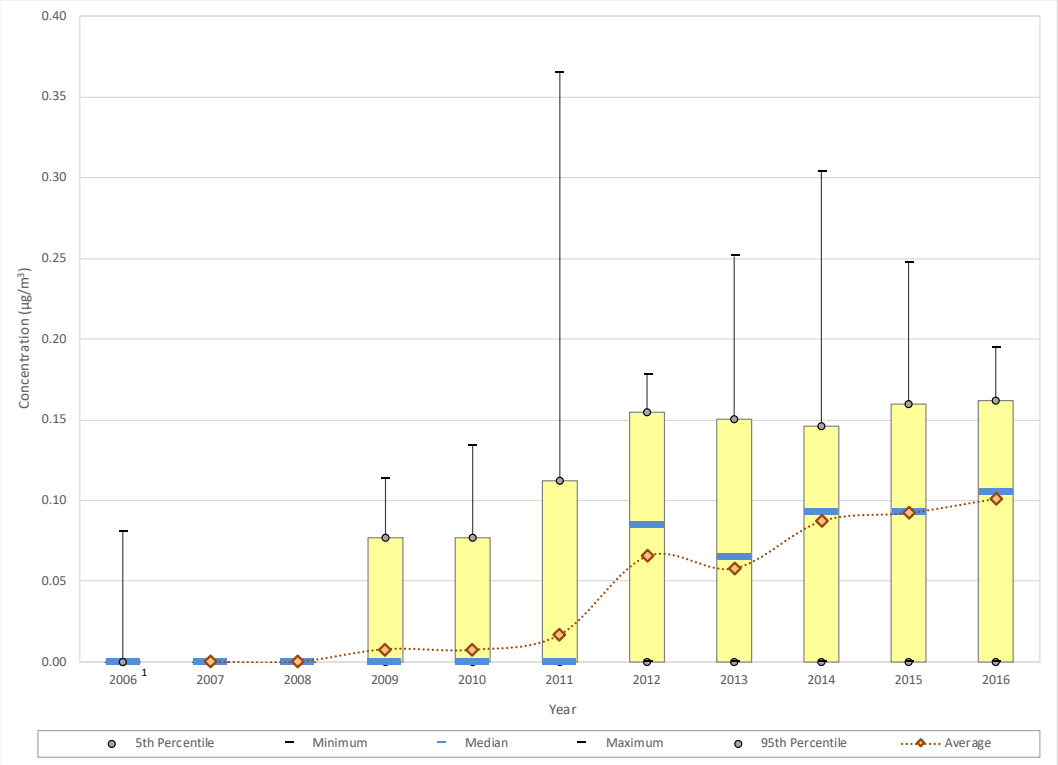
- Concentrations of *p*-dichlorobenzene decreased significantly from 2011 to 2012 and again in 2013. Concentrations greater than 0.2 µg/m^3 were not measured at TOOK in 2012 or 2013; the maximum concentration measured in 2013 is less than the 1-year average and median concentrations for several of the previous years.

- The concentration profile for 2014 resembles the concentration profile for 2012.

- Despite slight increases in the maximum concentration over the last few years of sampling, both the 1-year average and median concentration exhibit slight decreases for 2015 and 2016.

- There were no non-detects of *p*-dichlorobenzene measured in 2006 or 2007. The minimum concentration and 5th percentile are zero for most years after 2007, indicating the presence of non-detects. Between 2008 and 2012, the number of non-detects measured each year ranges from two (2009) to six (2010, 2011, and 2012). The number of non-detects increased four-fold for 2013 (24), decreased to 11 for both 2014 and 2015, then increased to 30 for 2016.

Figure 18-30. Yearly Statistical Metrics for 1,2-Dichloroethane Concentrations Measured at TOOK



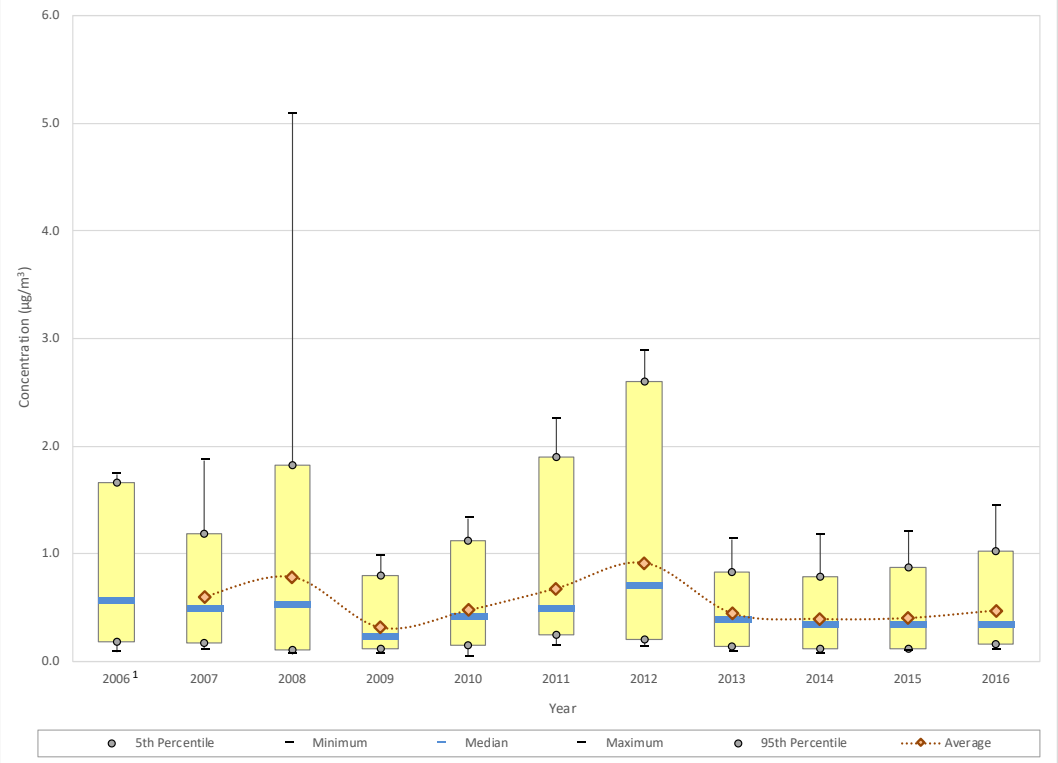
[1] A 1-year average is not presented because issues at the onset of sampling resulted in low completeness.

Observations from Figure 18-30 for 1,2-dichloroethane concentrations measured at TOOK include the following:

- The median concentration for each year through 2011 is zero, indicating that at least half of the measurements were non-detects. In 2006, there was one measured detection of 1,2-dichloroethane. In 2007 and 2008, there were none. Between 2009 and 2011, the number of measured detections varied from five to six. The number of measured detections increased significantly for 2012, up from six in 2011 to 38 in 2012. Slightly fewer measured detections were measured in 2013 (31), after which at least 50 measured detections were measured each year between 2014 and 2016. The 1-year average concentration increases (and decreases) correspondingly, with the 1-year average reaching 0.10 µg/m^3 for the first time in 2016.

- The 1-year average concentration is less than the corresponding median concentration for the last five years of sampling, which is a little unusual. The 1-year average concentration is more susceptible to outliers (on either end of the concentration range) than the median concentration, which represents the midpoint of a group of measurements. Here, concentrations on the lower end of the concentration range (the many zeroes representing non-detects) are pulling the average down (just like a maximum or outlier concentration can drive the average upward). The difference between the two statistical parameters decreases each year through 2015.

Figure 18-31. Yearly Statistical Metrics for Ethylbenzene Concentrations Measured at TOOK



[1] A 1-year average is not presented because issues at the onset of sampling resulted in low completeness.

Observations from Figure 18-31 for ethylbenzene concentrations measured at TOOK include the following:

- The two highest concentrations of ethylbenzene were both measured during the summer of 2008 (5.09 µg/m^3 and 4.57 µg/m^3). No other ethylbenzene concentrations greater than 3 µg/m^3 have been measured at TOOK since the onset of sampling. The next five highest concentrations, those between 2.50 µg/m^3 and 3 µg/m^3, were all measured at TOOK in 2012.

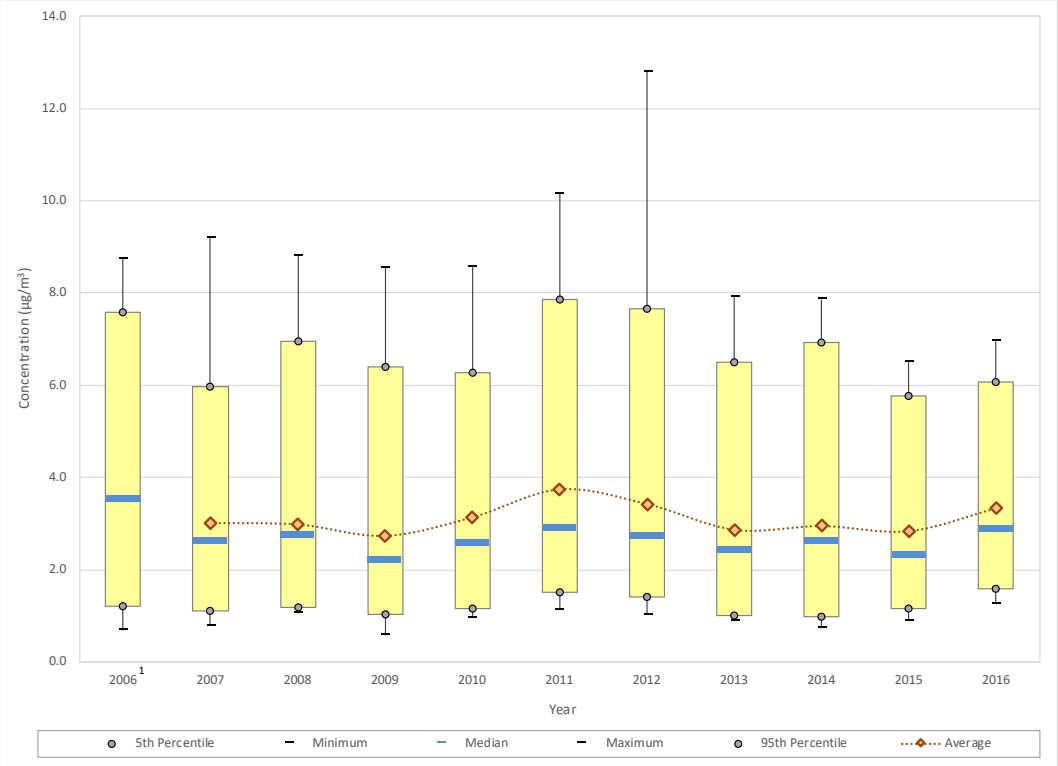
- The maximum, 95th percentile, and 1-year average concentrations exhibit increases from 2007 to 2008; the median also increased, although slightly. Even if the two highest concentrations measured in 2008 were excluded from the dataset, the 1-year average concentration would still exhibit a slight increase. A review of the data shows that the number of ethylbenzene concentrations greater than 1 µg/m^3 nearly doubled from 2007 (7) to 2008 (13).

- There were no ethylbenzene concentrations greater than 1 µg/m^3 measured at TOOK in 2009. Both the 1-year average and median concentrations are at a minimum for 2009, both decreasing by more than half from 2008 to 2009.

- After 2009, concentrations of ethylbenzene measured at TOOK exhibit a significant increasing trend through 2012. The 95th percentile, 1-year average concentration, and the median concentration are all at a maximum for 2012. The 95th percentile for 2012 is greater than the maximum concentration for all other years except 2008. The 1-year average concentration for 2012 is just less than 1 µg/m^3.

- Ethylbenzene concentrations measured in 2013 decreased significantly from 2012, with all of the statistical parameters exhibiting decreases, including the 1-year average concentration, which decreased by more than half. Relatively little change is shown for most of the statistical parameters between 2013 and 2015. Slight increases are shown for most of the statistical parameters for 2016, with the median concentration as the exception.

Figure 18-32. Yearly Statistical Metrics for Formaldehyde Concentrations Measured at TOOK



[1] A 1-year average is not presented because issues at the onset of sampling resulted in low completeness.

Observations from Figure 18-32 for formaldehyde concentrations measured at TOOK include the following:

- The maximum concentration of formaldehyde (12.8 µg/m^3) was measured at TOOK on June 26, 2012. One other measurement greater than 10 µg/m^3 has been measured at TOOK (10.2 µg/m^3 measured in 2011).

- All but one of the 102 formaldehyde concentrations greater than 5 µg/m^3 were measured at TOOK during the second and third quarters, particularly the period between June and August (accounting for 88 concentrations), regardless of year.

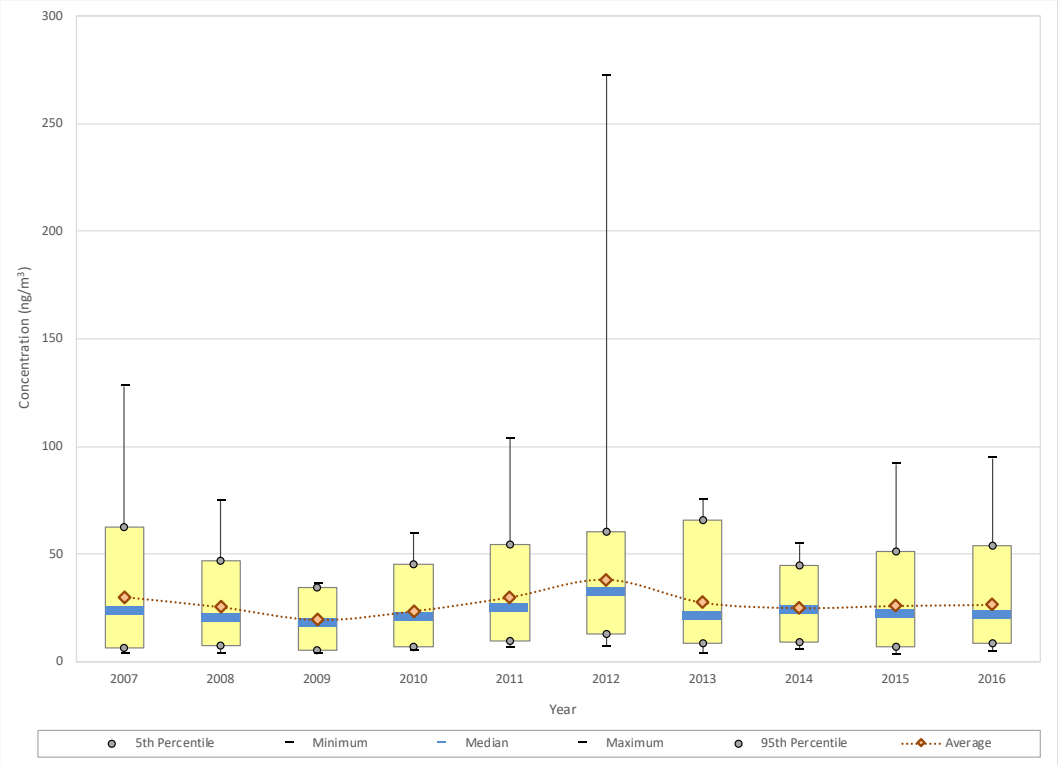
- The trends graph for formaldehyde resembles the graph for acetaldehyde, with an increasing trend in the 1-year average concentration shown for formaldehyde between 2009 and 2011. The 1-year average increased by 1 µg/m^3 over this period (with increases exhibited by the median concentration as well).

- Even though the maximum formaldehyde concentration was measured in 2012, all of the other statistical parameters exhibit slight decreases. Additional decreases are shown for all of the statistical parameters for 2013.

- Relatively little change in the central tendency parameters is shown between 2013 and 2015.

- Each of the statistical parameters exhibits an increase for 2016, with the median concentration exhibiting the largest change.

Figure 18-33. Yearly Statistical Metrics for Manganese (TSP) Concentrations Measured at TOOK



Observations from Figure 18-33 for manganese (TSP) concentrations measured at TOOK include the following:

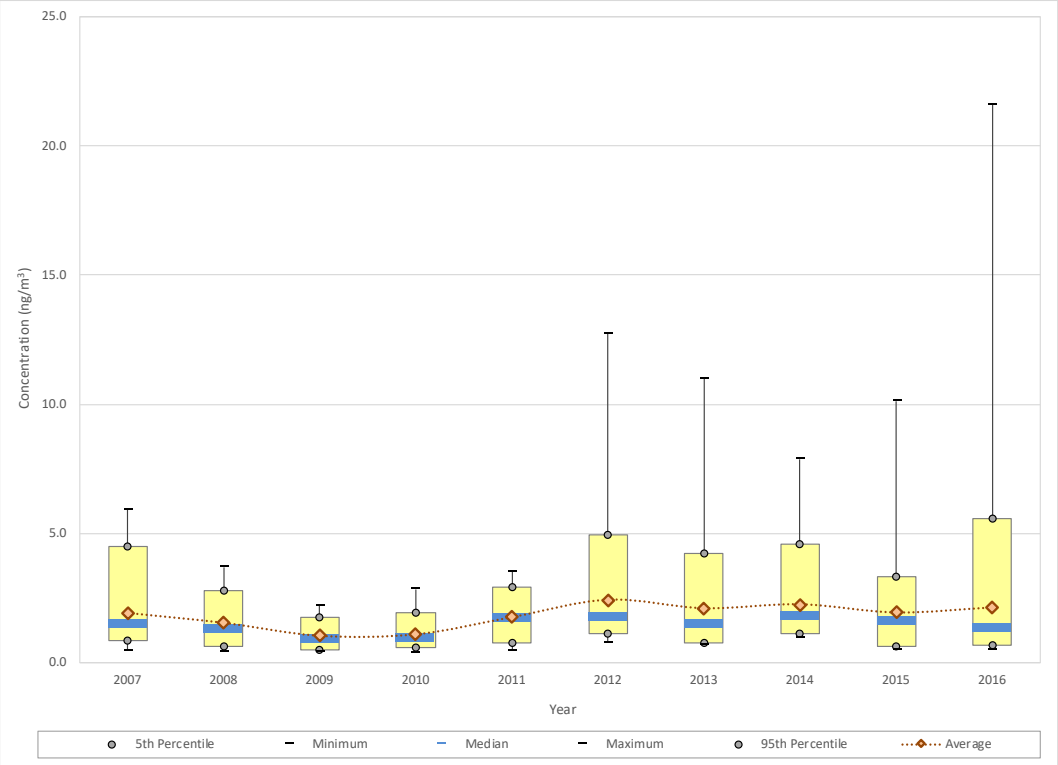
- The maximum concentration of manganese was measured in 2012 (273 ng/m^3), on the day of a dust storm (October 18, 2012). Measurements greater than 100 ng/m^3 were also measured in 2007 (128 ng/m^3) and 2011 (104 ng/m^3).

- A decreasing trend in manganese concentrations is shown through 2009, which was followed by an increasing trend through 2012. Even if the maximum concentration measured in 2012 was excluded from the calculations, the 1-year average and median concentrations would still exhibit an increasing trend for 2012. This is because there were more concentrations at the upper end of the concentration range for 2012 (the number of manganese concentrations greater than 50 ng/m^3 increased from four in 2011 to 12 in 2012) as well as fewer concentrations at the lower end of the concentration range (the number of manganese concentrations less than 20 ng/m^3 decreased from 17 in 2011 to 11 in 2012).

- With the exception of the 95th percentile, all of the statistical parameters exhibit decreases from 2012 to 2013. Both the 1-year average and median concentrations of manganese decreased by more than 10 ng/m^3 from 2012 to 2013.

- Despite differences in the range of concentrations measured, the central tendency parameters exhibited relatively little change between 2013 and 2016. These parameters vary by less than 2.5 ng/m^3 across the last four years of sampling shown.

Figure 18-34. Yearly Statistical Metrics for Nickel (TSP) Concentrations Measured at TOOK



Observations from Figure 18-34 for nickel (TSP) concentrations measured at TOOK include the following:

- The maximum concentration of nickel (21.6 ng/m^3) was measured at TOOK on September 27, 2016. Three additional nickel concentrations greater than 10 ng/m^3 have been measured at TOOK (including one on October 18, 2012, the day of a dust storm). In total, 18 nickel concentrations greater than 5 ng/m^3 have been measured at TOOK, with all but two measured in 2012 or later (with the two exceptions measured in 2007).

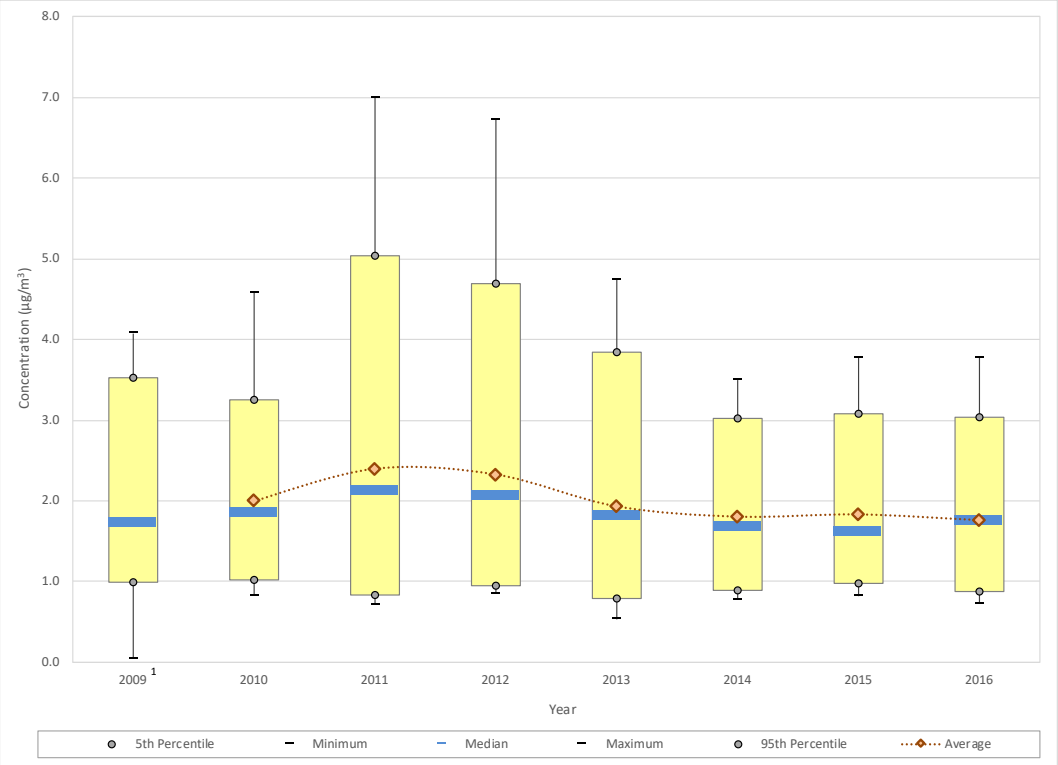
- A significant decreasing trend in the nickel concentrations measured at TOOK is shown through 2009. A slight increase is shown for 2010, which was followed by significant increases for 2011 and 2012.

- With the exception of the maximum concentration, the concentration profiles shown for the last five years of sampling more closely resemble the concentration profiles shown for 2007 than the years in-between.

- Despite some of the highest nickel concentrations measured, the median concentration exhibits a decrease from 2014 to 2015 and again for 2016. An

increasing number of nickel concentrations less than 1 ng/m^3 were measured at TOOK during this time, from a minimum of one in 2014 to eight in 2015 and 18 in 2016, the most since 2010.

Figure 18-35. Yearly Statistical Metrics for Acetaldehyde Concentrations Measured at TMOK



[1] A 1-year average is not presented because sampling under the NMP did not begin until April 2009.

Observations from Figure 18-35 for acetaldehyde concentrations measured at TMOK include the following:

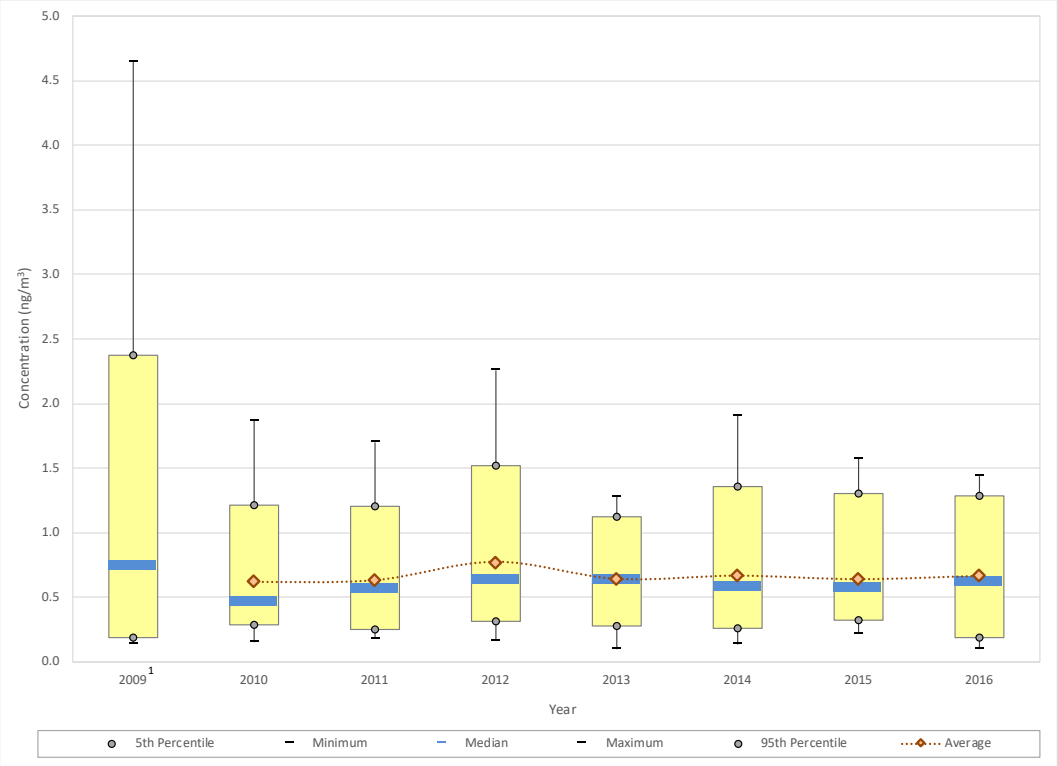
- Sampling for carbonyl compounds began at TMOK under the NMP in April 2009. A 1-year average concentration is not presented for 2009 because a full year's worth of data is not available, although the range of measurements is provided.

- The maximum acetaldehyde concentration (7.00 µg/m^3) was measured at TMOK on August 19, 2011. All seven acetaldehyde concentrations greater than 5 µg/m^3 were measured in either 2011 or 2012.

- The range of acetaldehyde concentrations measured increased considerably from 2010 to 2011, when the number of acetaldehyde concentrations greater than 3 µg/m^3 measured at TMOK increased three-fold, from five in 2010 to 15 in 2011. After 2011 the range of measurements decreased each year through 2014.

- A decreasing trend is shown in the 1-year average concentrations between 2011 and 2014, with little change shown for 2015 and 2016. The median concentration exhibits a similar trend, although an increase is shown for 2016.

Figure 18-36. Yearly Statistical Metrics for Arsenic (TSP) Concentrations Measured at TMOK



[1] A 1-year average is not presented because sampling under the NMP did not begin until April 2009.

Observations from Figure 18-36 for arsenic (TSP) concentrations measured at TMOK include the following:

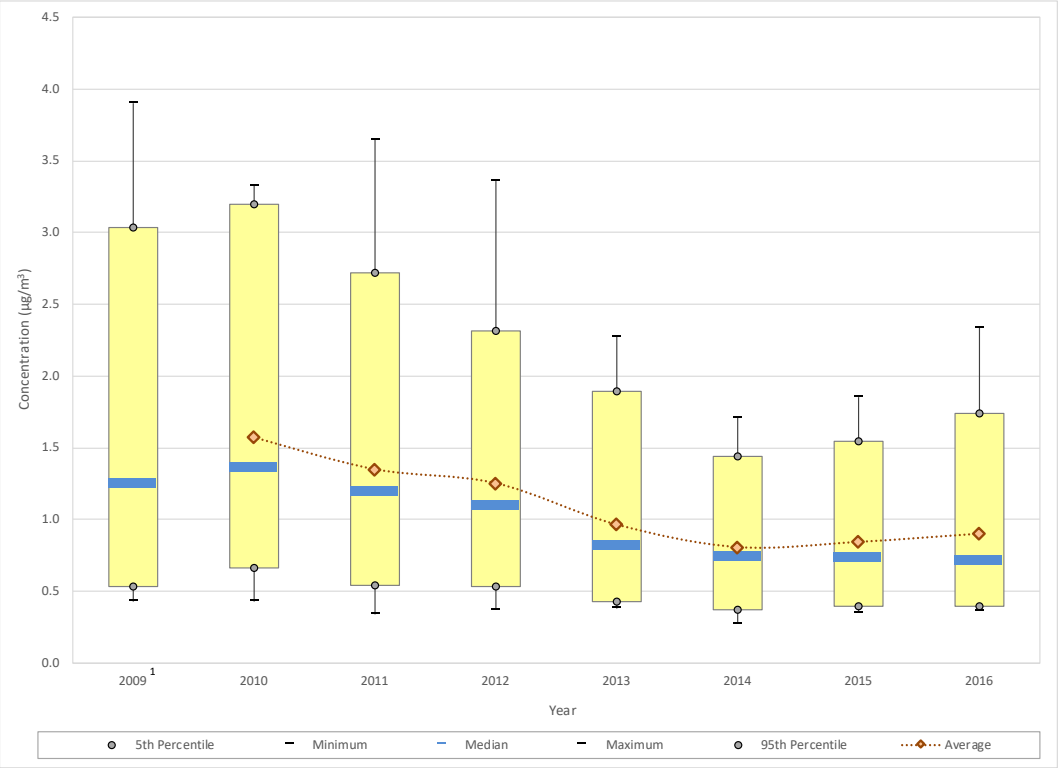
- Sampling for TSP metals began at TMOK under the NMP in April 2009. A 1-year average concentration is not presented for 2009 because a full year's worth of data is not available, although the range of measurements is provided.

- Five of the six arsenic concentrations greater than 2 ng/m^3 were measured at TMOK in 2009, including the two highest measurements (4.65 ng/m^3 and 3.11 ng/m^3). The entire range of concentrations measured in other years is less than the 95th percentile for 2009 and the median concentration is at a maximum for 2009.

- With the exception of 2012, the 1-year average concentrations vary between 0.6 ng/m^3 and 0.7 ng/m^3. Most of the statistical parameters exhibit increases for 2012, as the number of arsenic concentrations greater than 1 ng/m^3 measured in 2012 (15) is greater than the number measured during most other years, with the exception of 2009 (16).

- Excluding 2009, the statistical metrics for arsenic concentrations measured at TMOK resemble those shown in Figure 18-25 for TOOK.

Figure 18-37. Yearly Statistical Metrics for Benzene Concentrations Measured at TMOK



[1] A 1-year average is not presented because sampling under the NMP did not begin until April 2009.

Observations from Figure 18-37 for benzene concentrations measured at TMOK include the following:

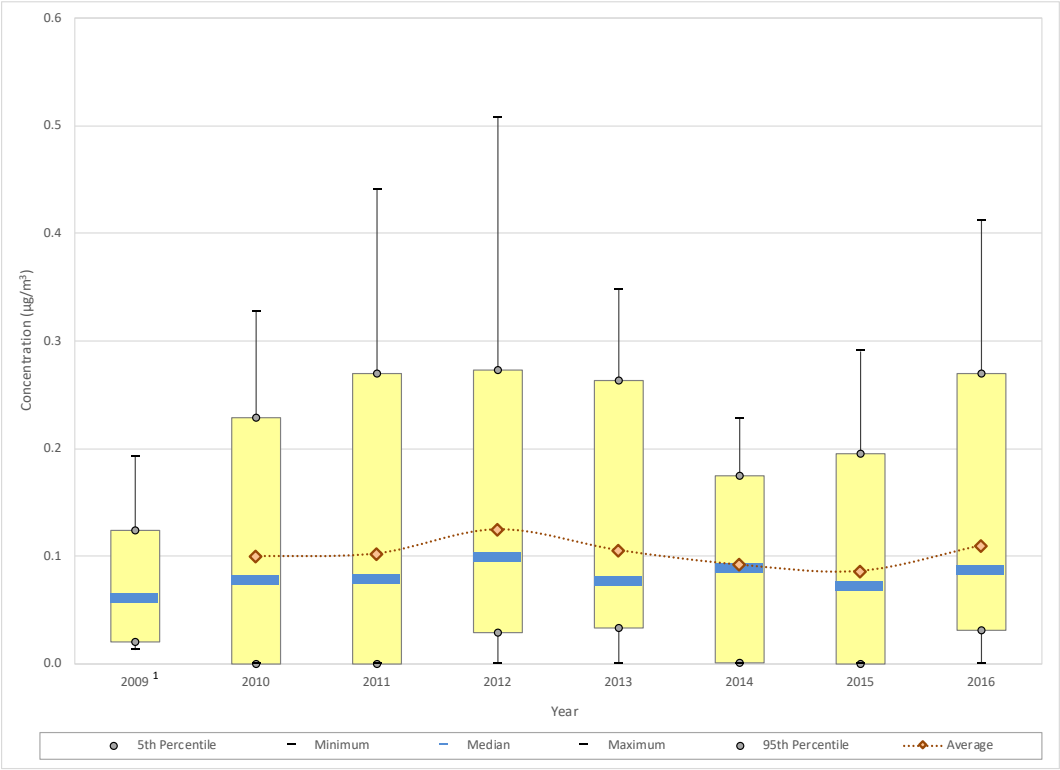
- Sampling for VOCs began at TMOK under the NMP in April 2009. A 1-year average concentration is not presented for 2009 because a full year's worth of data is not available, although the range of measurements is provided.

- The maximum benzene concentration (3.91 µg/m^3) was measured at TMOK on May 7, 2009, although additional benzene concentrations greater than 3 µg/m^3 were measured each year between 2009 and 2012.

- The 1-year average benzene concentration has a significant decreasing trend between 2010 and 2014, with the largest year-to-year decrease shown from 2012 to 2013. The 1-year average decreased by half during this time. The median concentration also decreases between 2010 and 2014 but continues to decrease through 2016 (while the 1-year average exhibits a slight increase during the last two years). The median concentration has also decreased by half since the onset of sampling.

- The range of benzene concentrations measured is at a minimum for 2014 then increases slightly for 2015 and again for 2016. Between 2014 and 2016, the 1-year average concentration of benzene increased only slightly (by 0.1 µg/m^3).

Figure 18-38. Yearly Statistical Metrics for 1,3-Butadiene Concentrations Measured at TMOK



[1] A 1-year average is not presented because sampling under the NMP did not begin until April 2009.

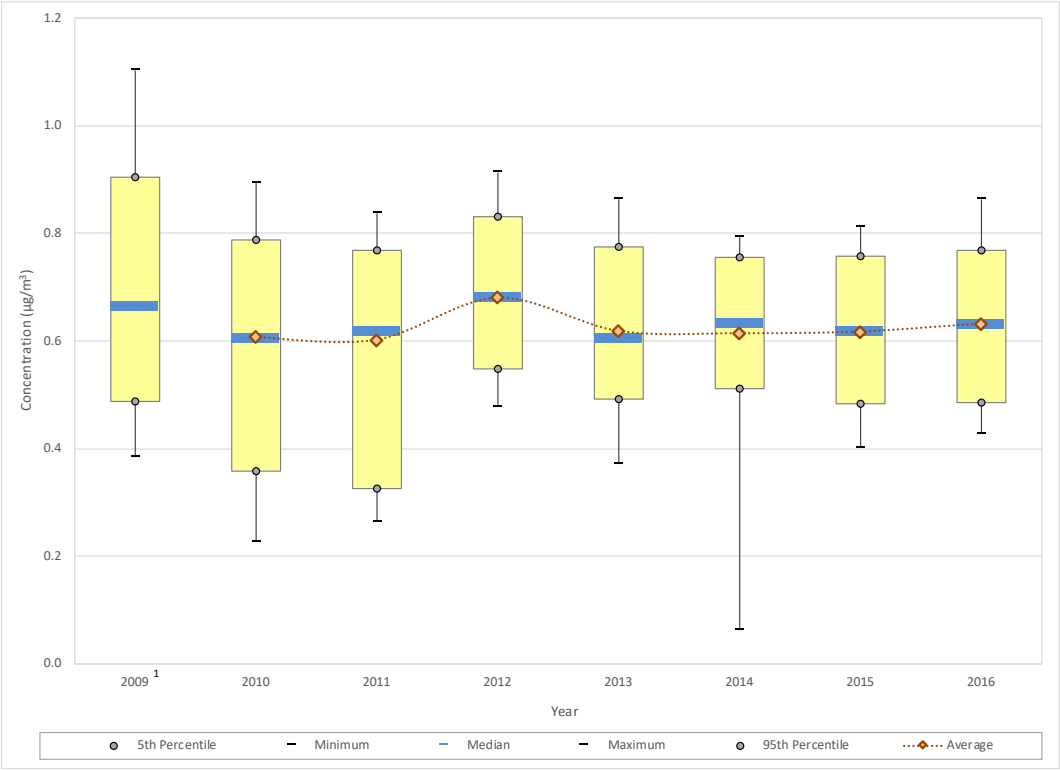
Observations from Figure 18-38 for 1,3-butadiene concentrations measured at TMOK include the following:

- The range of 1,3-butadiene concentrations measured at TMOK is at a minimum for 2009, with all concentrations measured spanning less than 0.2 µg/m^3. The range of concentrations measured then increases each year through 2012. After 2012, the range of measurements decreases for two years then increases for two years, such that the concentration profiles for 2013 and 2016 resemble each other.

- Despite the differences in the concentrations measured, less than 0.04 µg/m^3 separates the 1-year average concentrations across the years shown, which range from 0.09 µg/m^3 (2015) to 0.13 µg/m^3 (2012).

- The number of non-detects has varied across the years of sampling, from a few as none (2009) to as many as nine (2011).

Figure 18-39. Yearly Statistical Metrics for Carbon Tetrachloride Concentrations Measured at TMOK



[1] A 1-year average is not presented because sampling under the NMP did not begin until April 2009.

Observations from Figure 18-39 for carbon tetrachloride concentrations measured at TMOK include the following:

- The maximum carbon tetrachloride concentration was measured on August 17, 2009 and is the only concentration greater than 1 µg/m^3 measured at TMOK.

- All of the statistical parameters exhibit decreases from 2009 to 2010, with little change in the carbon tetrachloride measurements at TMOK shown from 2010 to 2011.

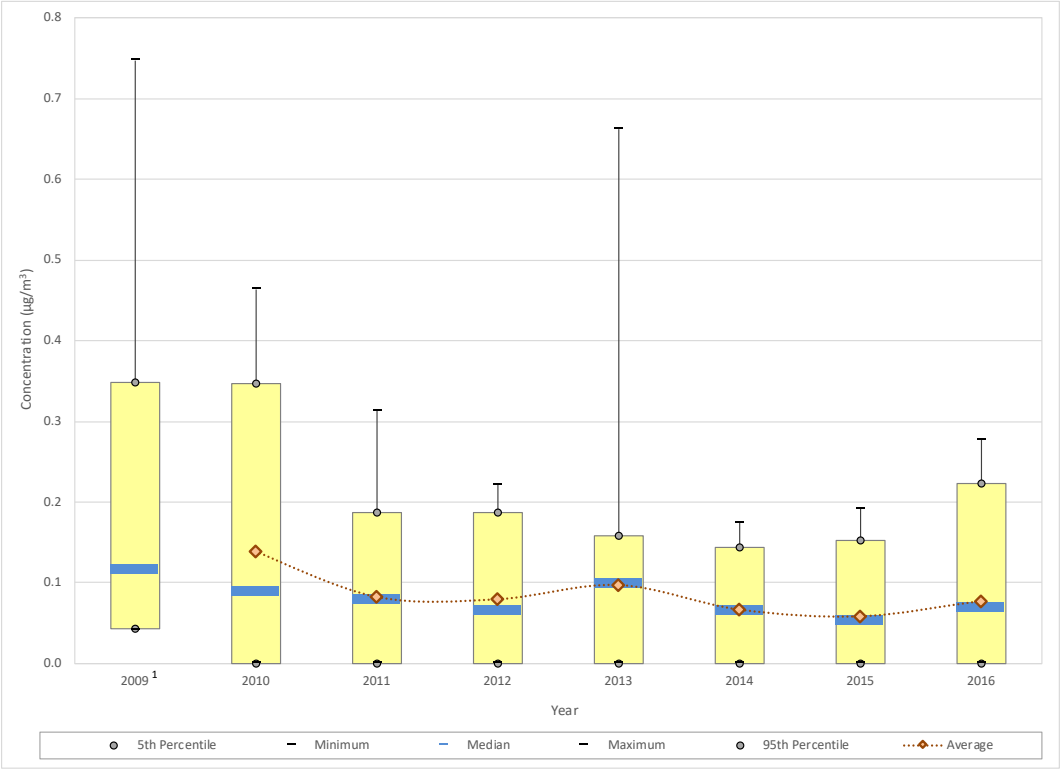
- All of the statistical parameters exhibit increases for 2012, despite the compressed range of concentrations measured. The number of carbon tetrachloride concentrations greater than 0.6 µg/m^3 was at a maximum for 2012, accounting for 51 of the 61 measurements (compared to between 30 and 40 for most of the other years shown).

- All of the statistical parameters exhibit decreases from 2012 to 2013, with several parameters exhibiting additional decreases for 2014. The minimum concentration measured in 2014 (0.063 µg/m^3) is considerably less than other carbon tetrachloride concentrations measured at TMOK.

- With the exception of 2012, the 1-year average concentrations of carbon tetrachloride fall between 0.60 µg/m^3 and 0.65 µg/m^3. This is also true for the median

concentrations, excluding 2009. The 1-year average and median concentrations for 2012 are only slightly outside this range, at 0.68 µg/m^3 each.

Figure 18-40. Yearly Statistical Metrics for *p*-Dichlorobenzene Concentrations Measured at TMOK



[1] A 1-year average is not presented because sampling under the NMP did not begin until April 2009.

Observations from Figure 18-40 for *p*-dichlorobenzene concentrations measured at TMOK include the following:

- The maximum *p*-dichlorobenzene concentration was measured on June 30, 2009 (0.747 µg/m^3). Only one additional concentration greater than 0.5 µg/m^3 has been measured at TMOK (0.663 µg/m^3, measured in 2013).

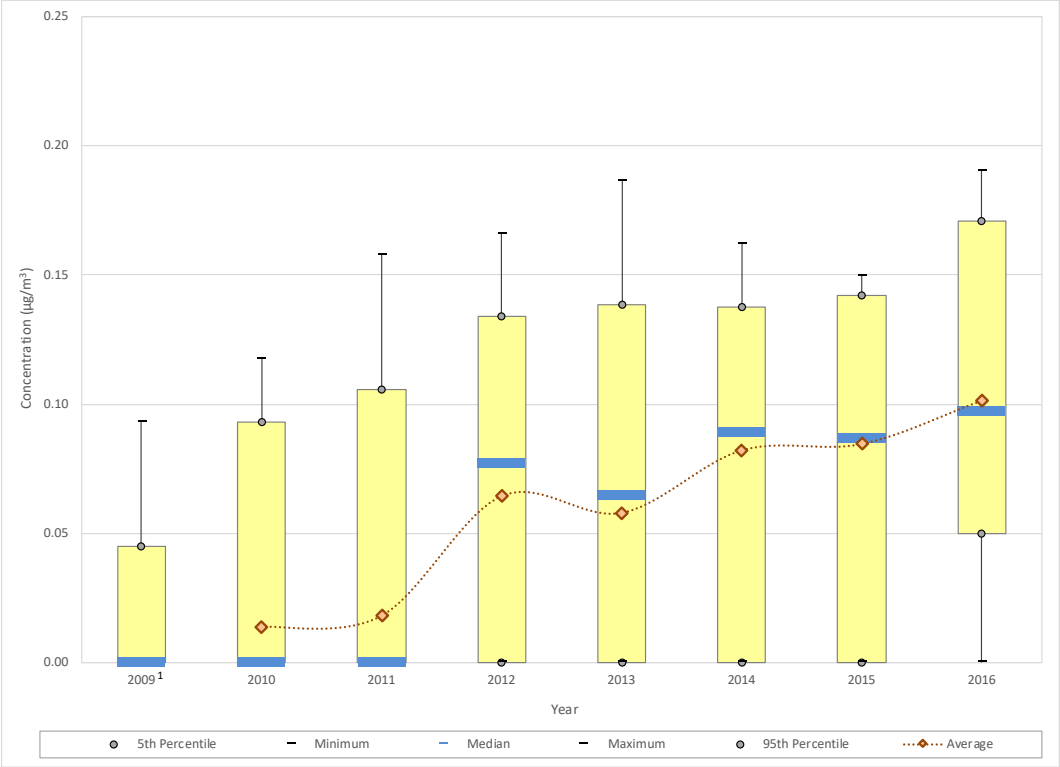
- A decreasing trend in concentrations of *p*-dichlorobenzene is shown through 2012. The median decreases by nearly half between 2009 and 2012 and 1-year average concentration decreased significantly from 2010 to 2011 with little change shown from 2011 to 2012.

- The increase in the 1-year average concentration shown for 2013 is not solely attributable to the maximum concentration measured that year, as the median concentration, which is less influenced by outliers, exhibits a similar increase. The number of concentrations greater than 0.1 µg/m^3 nearly doubled from 2012 (16) to 2013 (30).

- The decreasing trend in *p*-dichlorobenzene concentrations measured at TMOK shown prior to 2013 resumes in 2014 and 2015, when both central tendency parameters are at a minimum.

- Most of the statistical parameters exhibit slight increases for 2016, though confidence intervals indicate that the difference is not statistically significant.

Figure 18-41. Yearly Statistical Metrics for 1,2-Dichloroethane Concentrations Measured at TMOK



[1] A 1-year average is not presented because sampling under the NMP did not begin until April 2009.

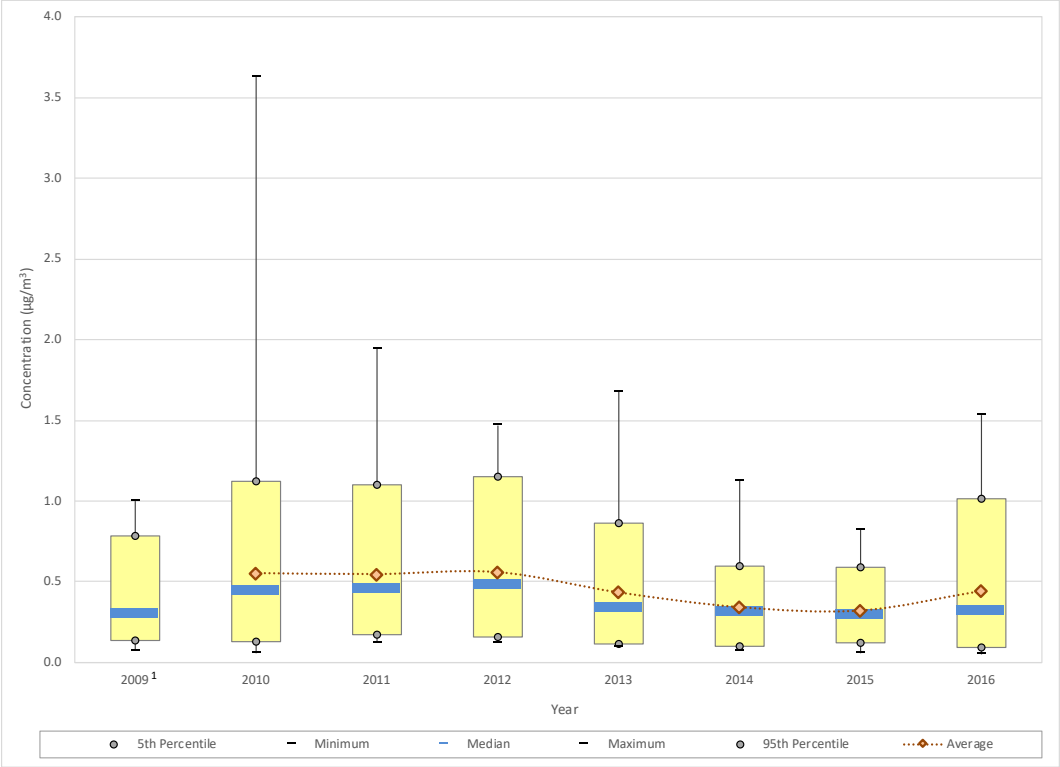
Observations from Figure 18-41 for 1,2-dichloroethane concentrations measured at TMOK include the following:

- The minimum, 5th percentile, and median concentrations for 2009, 2010, and 2011 are zero, indicating that at least half of the measurements were non-detects. In 2009, there were three measured detections of 1,2-dichloroethane. In 2010 and 2011, there were 10 each year. For 2012, the number of measured detections increased by a factor of four and the median concentration is greater than zero for the first time. Measured detections also accounted for more than half of measurements in 2013. By 2014, measured detections account for 85 percent of measurements, with the percentage increasing each year through 2016, when the 5th percentile is greater than zero for the first time. The 1-year average concentrations increase (and decrease) correspondingly, with the 1-year average reaching 0.10 µg/m^3 for the first time in 2016.

- The 1-year average concentration is more susceptible to outliers (on either end of the concentration range) than the median concentration. The 1-year average concentration for each year between 2012 and 2015 is less than the median, indicating that concentrations on the lower end of the concentration range (the zeroes representing non-detects) are pulling the 1-year average downward (just like a maximum or outlier concentration can drive the average upward). The 1-year average concentration for 2016 is greater than the median concentration, when the fewest non-detects were measured (three).

- Figure 18-41 for 1,2-dichloroethane concentrations measured at TMOK resembles Figure 18-30 for 1,2-dichloroethane concentrations measured at TOOK.

Figure 18-42. Yearly Statistical Metrics for Ethylbenzene Concentrations Measured at TMOK



[1] A 1-year average is not presented because sampling under the NMP did not begin until April 2009.

Observations from Figure 18-42 for ethylbenzene concentrations measured at TMOK include the following:

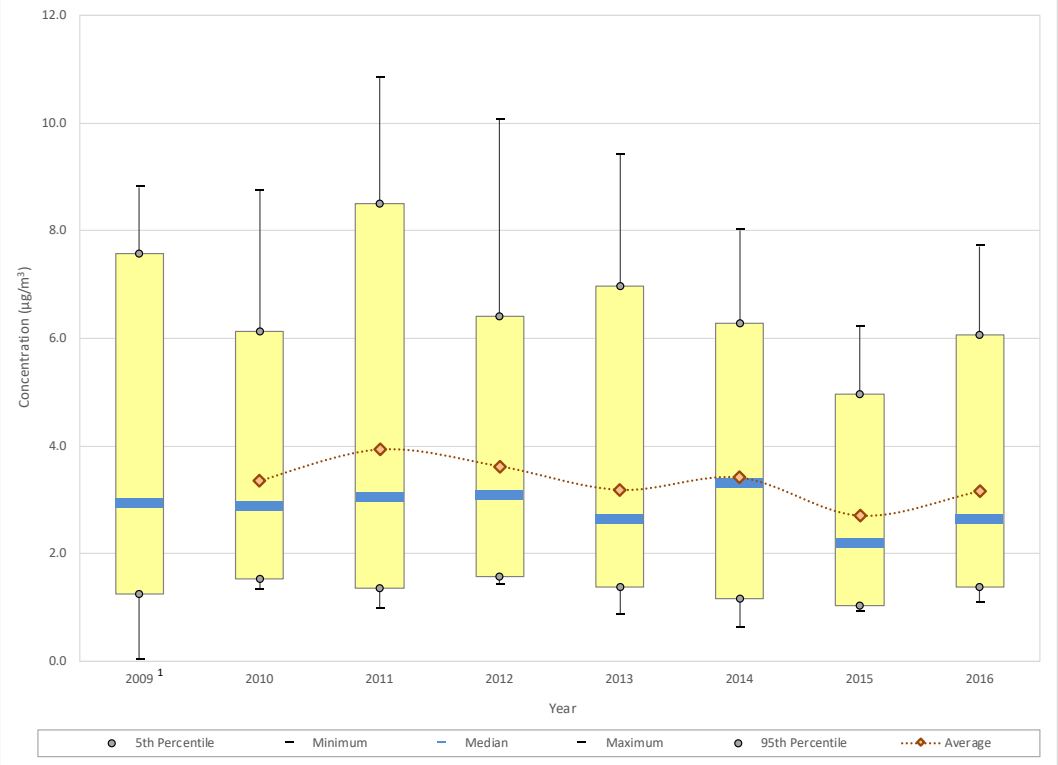
- The maximum ethylbenzene concentration was measured in 2010 (3.63 µg/m^3) and is the only measurement greater than 2 µg/m^3 measured at TMOK.

- Despite the decrease in the maximum concentrations shown between 2010 and 2012, little change is shown for most of the statistical parameters. Less than 0.04 µg/m^3 separates the median concentrations for these years and approximately 0.01 µg/m^3 separates the 1-year average concentrations during this period.

- A significant decreasing trend in ethylbenzene concentrations is shown after 2012. Most of the statistical parameters are at a minimum for 2015, the first year ethylbenzene concentrations greater than 1 µg/m^3 were not measured.

- Several of the statistical parameters exhibit increases for 2016. Eight concentrations measured in 2016 are higher than the maximum concentration measured in 2015. Yet, both the minimum concentration and 5th percentile are at a minimum for 2016.

Figure 18-43. Yearly Statistical Metrics for Formaldehyde Concentrations Measured at TMOK



[1] A 1-year average is not presented because sampling under the NMP did not begin until April 2009.

Observations from Figure 18-43 for formaldehyde concentrations measured at TMOK include the following:

- The maximum formaldehyde concentration was measured on August 19, 2011 (10.8 µg/m^3), the same date that the maximum acetaldehyde concentration was measured at TMOK. Two additional formaldehyde concentrations greater than 10 µg/m^3 were measured at TMOK in 2012.

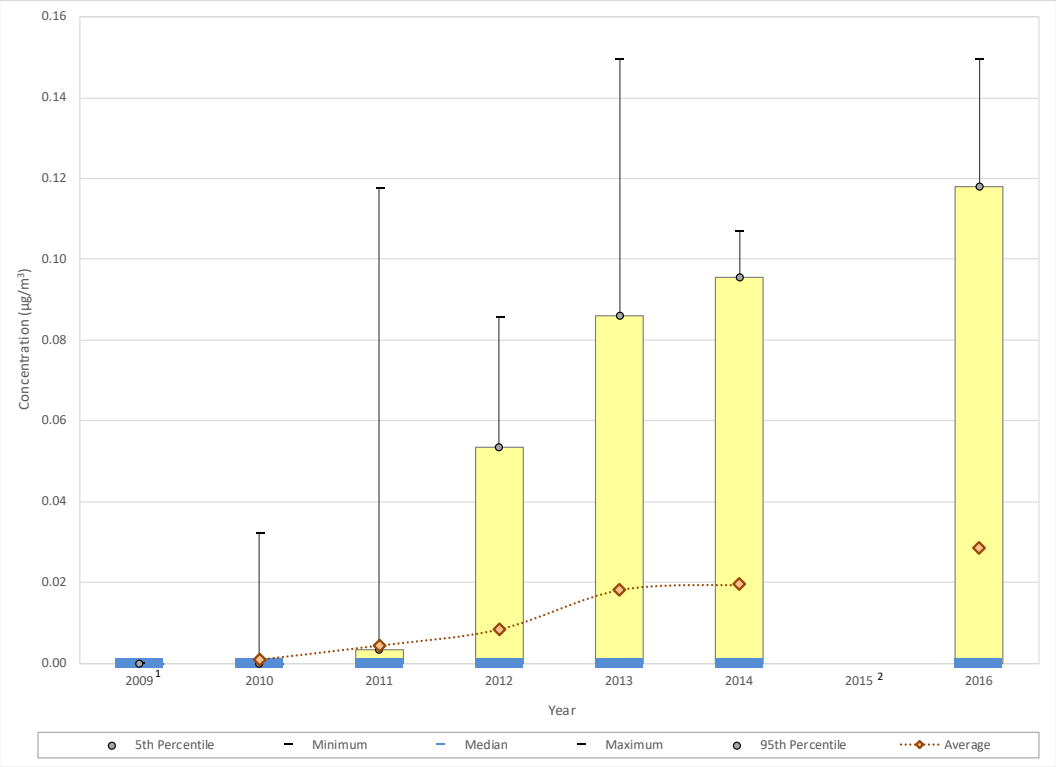
- Most of the statistical parameters exhibit increases from 2010 to 2011, when the number of formaldehyde concentrations greater than 5 µg/m^3 nearly doubled (from 10 measured in 2010 to 19 measured in 2011).

- After 2011, the maximum formaldehyde concentration measured at TMOK decreases each year through 2015. The 95th percentile decreases across most of these years, as does the 1-year average and median concentrations (though 2014 is the exception).

Most of the statistical parameters are at a minimum for 2015, the only year in which the 1-year average concentration is less than 3 µg/m^3.

- Each of the statistical parameters exhibits an increase for 2016.

Figure 18-44. Yearly Statistical Metrics for Hexachloro-1,3-butadiene Concentrations Measured at TMOK



[1] A 1-year average is not presented because sampling under the NMP did not begin until April 2009.
[2] A concentration profile is not presented due to a laboratory contamination issue affecting numerous samples.

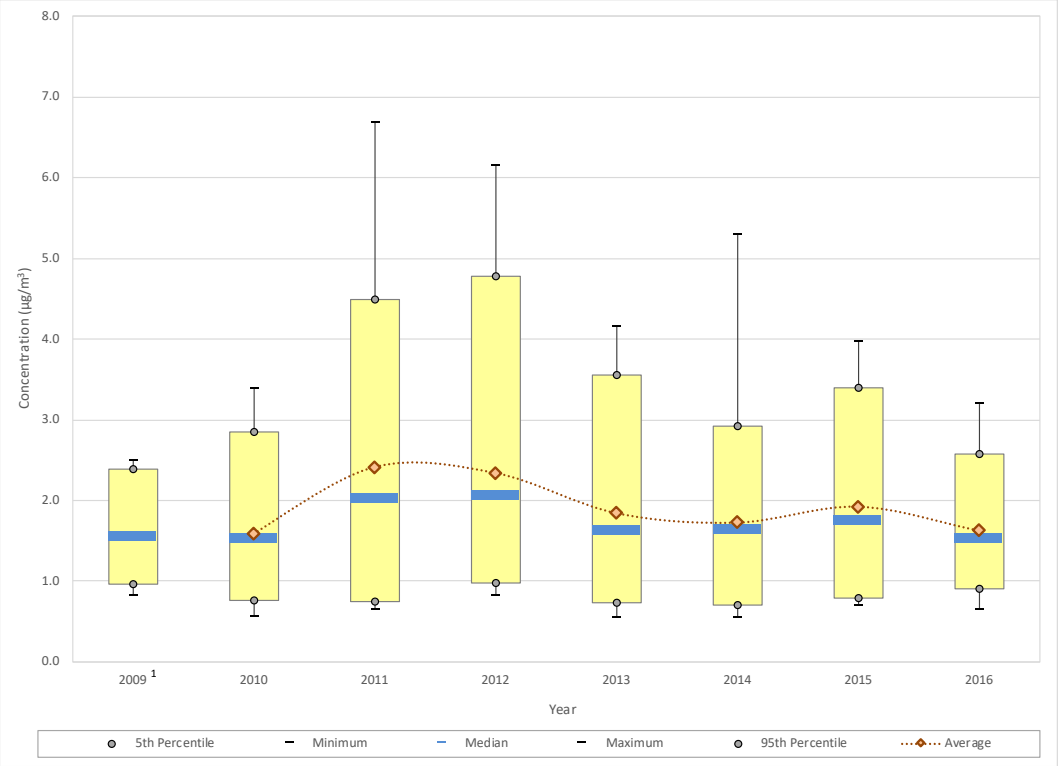
Observations from Figure 18-44 for hexachloro-1,3-butadiene concentrations measured at TMOK include the following:

- The use of a contaminated internal standard at the laboratory for Method TO-15 resulted in the invalidation of the hexachloro-1,3-butadiene measurements from early March 2015 through mid-December 2015, as described in Section 2.4. As a result, a concentration profile for 2015 is not presented.

- There were few measured detections of hexachloro-1,3-butadiene in the first few years of sampling at TMOK. The median concentration is zero for all years of sampling, indicating that at least half of the measurements were non-detects for each year. The number of measured detections ranges from zero in 2009 to 18 in 2016, increasing by a few each year.

- All concentrations of hexachloro-1,3-butadiene measured at TMOK are less than the MDL.

Figure 18-45. Yearly Statistical Metrics for Acetaldehyde Concentrations Measured at OCOK



[1] A 1-year average is not presented because sampling under the NMP did not begin until May 2009.

Observations from Figure 18-45 for acetaldehyde concentrations measured at OCOK include the following:

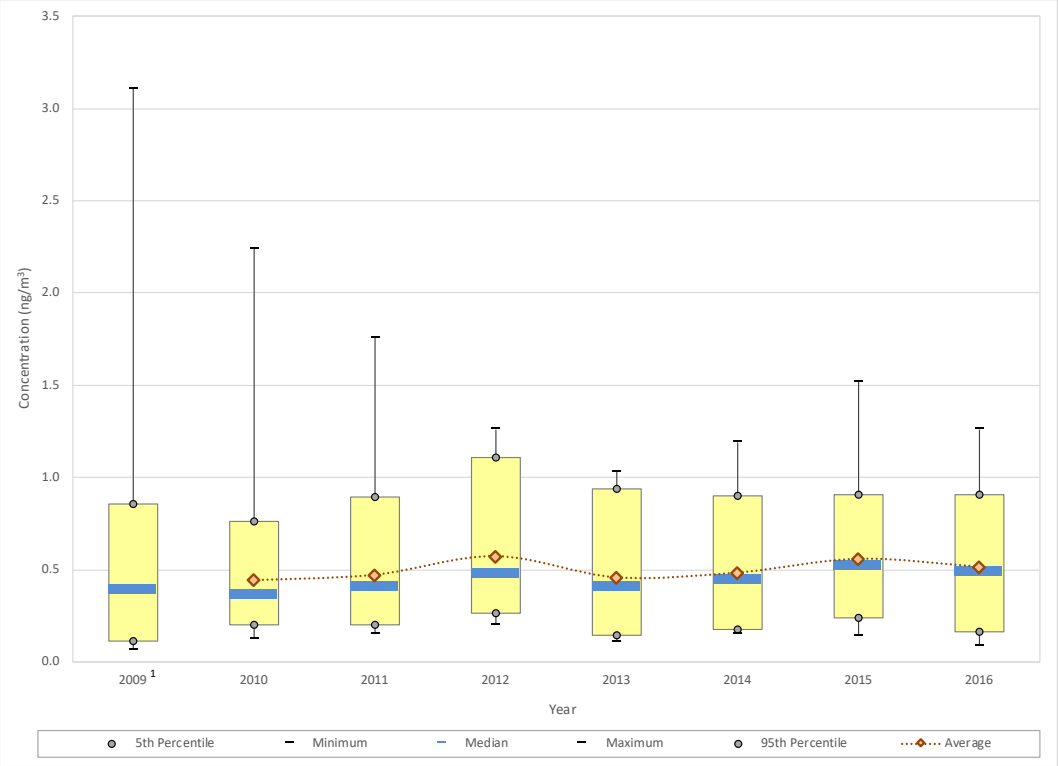
- Sampling for carbonyl compounds began at OCOK under the NMP in May 2009. A 1-year average concentration is not presented for 2009 because a full year's worth of data is not available, although the range of measurements is provided.

- The maximum acetaldehyde concentration was measured on May 9, 2011 (6.68 µg/m^3). One additional acetaldehyde concentration greater than 6 µg/m^3 has been measured at OCOK (6.16 µg/m^3 in 2012).

- The smallest range of acetaldehyde concentrations was measured in 2009, after which the range of measurements increased considerably. The 1-year average concentration increased significantly from 2010 to 2011, with the median concentration exhibiting a similar increase. Fifteen concentrations measured in 2011 (or one-quarter of the measurements) are greater than the maximum concentration measured in 2010. Little change in these parameters is shown from 2011 to 2012.

- A decreasing trend in acetaldehyde concentrations is shown after 2012. Slight increases are shown for 2015, before additional decreases are exhibited for 2016. The 1-year average and median concentrations for 2016 are at their lowest since the first full year of sampling at OCOK.

Figure 18-46. Yearly Statistical Metrics for Arsenic (TSP) Concentrations Measured at OCOK



[1] A 1-year average is not presented because sampling under the NMP did not begin until May 2009.

Observations from Figure 18-46 for arsenic (TSP) concentrations measured at OCOK include the following:

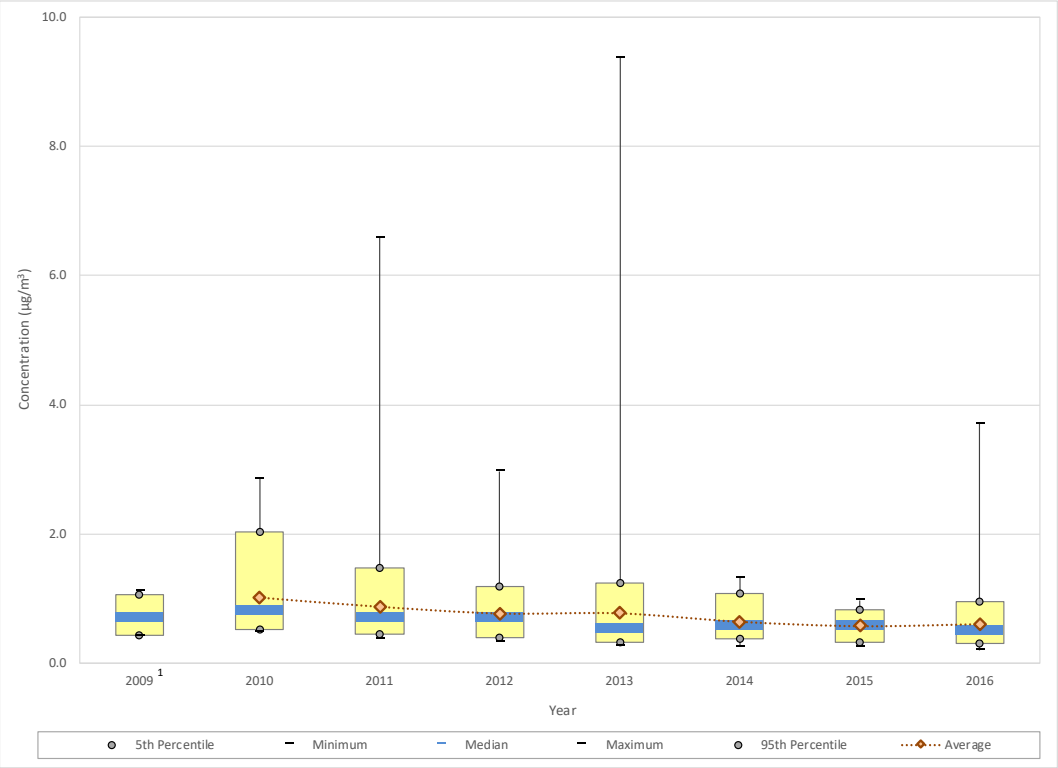
- Sampling for TSP metals began at OCOK under the NMP in May 2009. A 1-year average concentration is not presented for 2009 because a full year's worth of data is not available, although the range of measurements is provided.

- The maximum concentration of arsenic was measured at OCOK in 2009 (3.11 ng/m^3). Despite decreasing maximum concentrations after 2009, both the 1-year average and median concentrations exhibit increases through 2012. This is due to a higher number of concentrations at the upper end of the concentration range as well as fewer concentrations at the lower end of the concentration range.

- Each of the statistical parameters exhibit a decrease for 2013, when the entire range of arsenic concentrations measured at OCOK spans less than 1 ng/m^3.

- Although variations in the 1-year average and median concentrations are shown between 2013 and 2016, the majority of measurements collected during this period fall into relatively similar ranges, as indicated by the 5th and 95th percentiles.

Figure 18-47. Yearly Statistical Metrics for Benzene Concentrations Measured at OCOK



[1] A 1-year average is not presented because sampling under the NMP did not begin until May 2009.

Observations from Figure 18-47 for benzene concentrations measured at OCOK include the following:

- Sampling for VOCs began at OCOK under the NMP in May 2009. A 1-year average concentration is not presented for 2009 because a full year's worth of data is not available, although the range of measurements is provided.

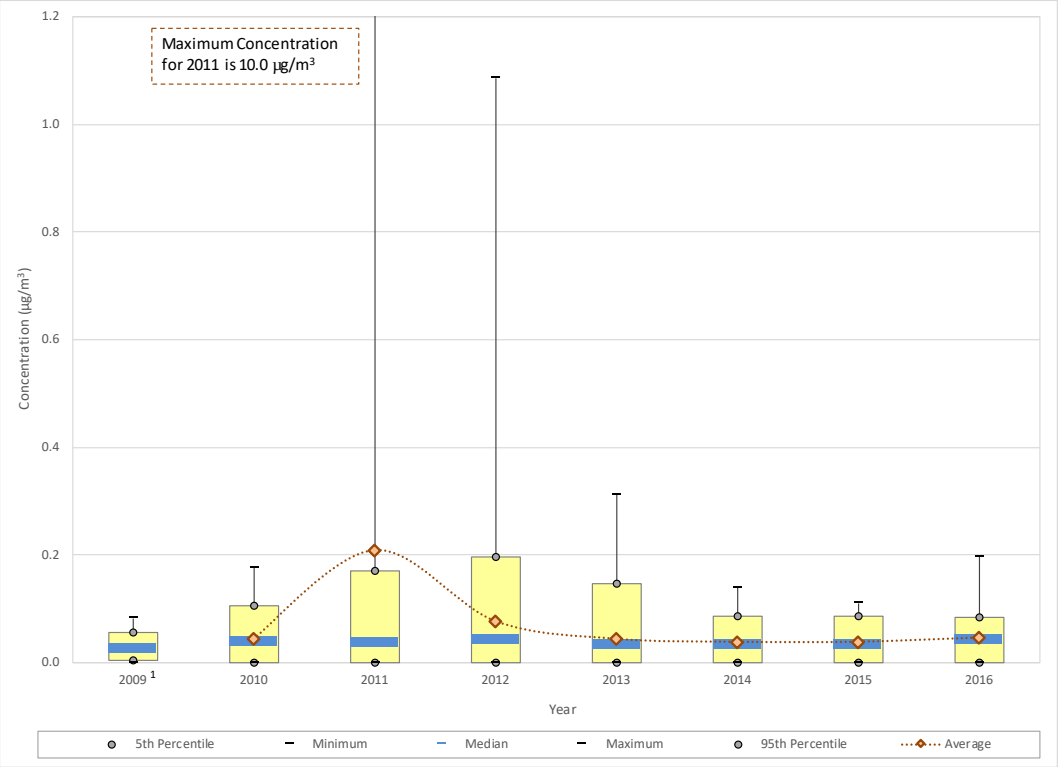
- The maximum benzene concentration was measured at OCOK on November 6, 2013 (9.38 µg/m^3). The next highest concentration was measured on September 18, 2011 (6.80 µg/m^3). Additional benzene concentrations greater than 4 µg/m^3 have not been measured at OCOK.

- With the exception of 2013, the 1-year average concentration has a decreasing trend between 2010 and 2015. If the maximum concentration measured in 2013 was excluded from the calculation, the 1-year average concentration would have a continuous decreasing trend through 2013, virtually no change for 2014, and further decreases for 2015.

- Benzene concentrations measured at OCOK in 2015 exhibit the least amount of variability among the seven full years of sampling, as this year has the smallest range of measurements, the majority of concentrations fall into the smallest range, and the difference between the 1-year average and median concentrations is at a minimum.

- The slight increases shown for 2016 are primarily attributable to the maximum concentration measured (3.71 µg/m^3). If this measurement was excluded, the decreasing trend, however slight, would continue.

Figure 18-48. Yearly Statistical Metrics for 1,3-Butadiene Concentrations Measured at OCOK



[1] A 1-year average is not presented because sampling under the NMP did not begin until May 2009.

Observations from Figure 18-48 for 1,3-butadiene concentrations measured at OCOK include the following:

- The maximum 1,3-butadiene concentration was measured at OCOK on September 18, 2011 (10.0 µg/m^3), which is the same day the second highest benzene concentration was measured. The next highest concentration was measured in 2012 (1.09 µg/m^3). No other 1,3-butadiene concentrations greater than 0.35 µg/m^3 have been measured at OCOK.

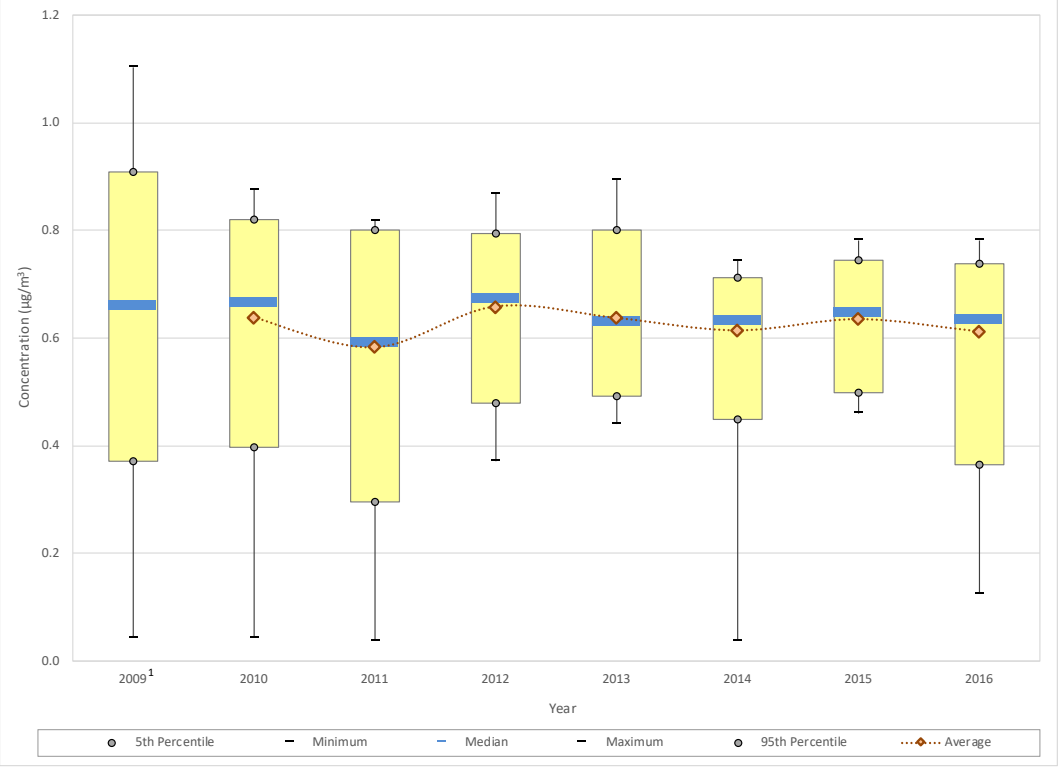
- The 1-year average concentration for 2011 is being driven by the outlier, as the 1-year average is greater than the 95th percentile for 2011. If this measurement was excluded from the calculation, the 1-year average concentration would decrease from 0.21 µg/m^3 to 0.05 µg/m^3, resulting in a negligible change from 2010 levels.

- Excluding 2011, the 1-year average concentration for 2012 is higher than most other years of sampling (although difficult to discern in Figure 18-48). The 1-year average for 2012 is also influenced by a single higher concentration, though to a lesser extent than 2011. But this is not the only reason for the increase. The number of non-detects

measured decreased significantly from 2011 (20) to 2012 (5) before increasing again for 2013 (21).

- The median concentrations shown between 2010 and 2016 have varied by less than 0.01 µg/m^3 over the period, ranging from 0.035 µg/m^3 (2013, 2014) to 0.044 µg/m^3 (2012, 2016). Excluding 2011 and 2012, the 1-year average concentrations vary by less than 0.01 µg/m^3, ranging from 0.038 µg/m^3 (2014, 2015) to 0.046 µg/m^3 (2016).

Figure 18-49. Yearly Statistical Metrics for Carbon Tetrachloride Concentrations Measured at OCOK



[1] A 1-year average is not presented because sampling under the NMP did not begin until May 2009.

Observations from Figure 18-49 for carbon tetrachloride concentrations measured at OCOK include the following:

- The two highest concentrations of carbon tetrachloride were measured at OCOK in 2009, including one greater than 1 µg/m^3 (1.10 µg/m^3). The maximum concentration measured after 2009 are less than 0.90 µg/m^3, and less than 0.8 µg/m^3 for 2014 and later.

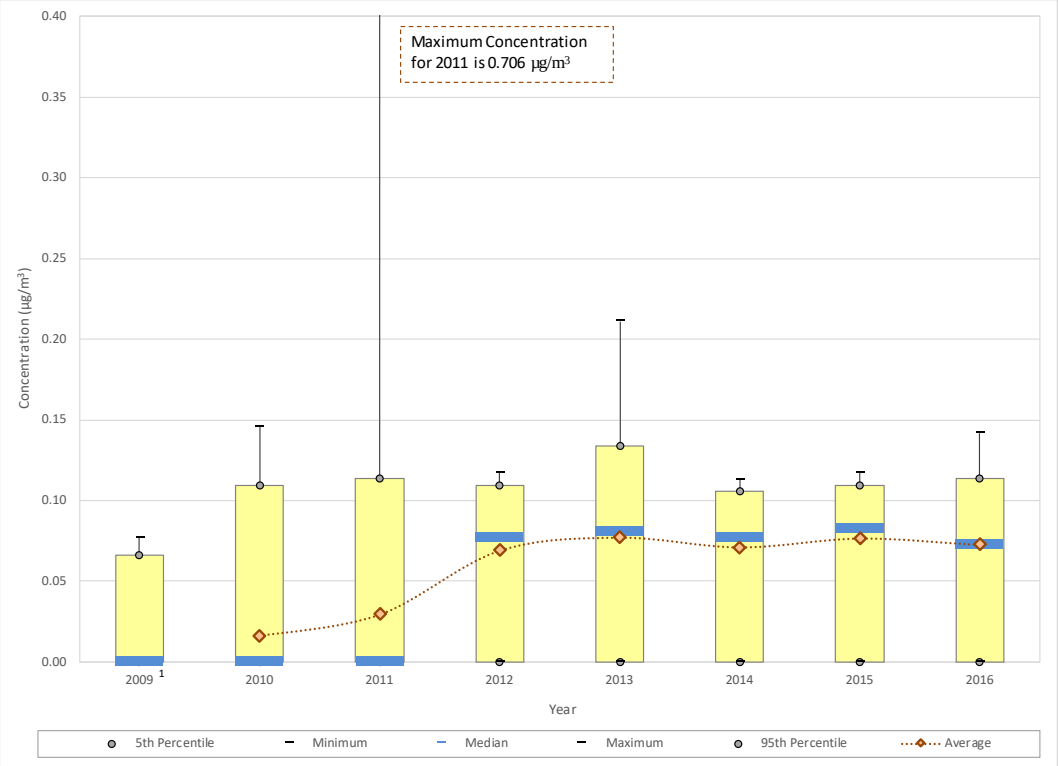
- The range of carbon tetrachloride concentrations measured at OCOK decreased each year through 2013, when all carbon tetrachloride concentrations measured span less than 0.50 µg/m^3.

- The 1-year average concentrations of carbon tetrachloride have varied by less than 0.1 µg/m^3, ranging from 0.58 µg/m^3 (2011) to 0.66 µg/m^3 (2012). The median

concentrations have a similar pattern, ranging from 0.59 µg/m^3 (2011) to 0.67 µg/m^3 (2012).

- With the exception of 2013, the median concentration is greater than the 1-year average concentration, which can be attributed to the few concentrations on the lower end of the concentration range, which can pull an average down in a similar manner to an outlying concentration driving the average up. In total, six carbon tetrachloride concentrations less than 0.2 µg/m^3 have been measured at OCOK, one each in 2009, 2010, 2014, and 2016, and two in 2011. This explains why the box and whisker plots for carbon tetrachloride appear "inverted" for several years, with the minimum concentration extending farther away from the majority of the measurements than the maximum concentration, which is more common (see acetaldehyde as an example).

Figure 18-50. Yearly Statistical Metrics for 1,2-Dichloroethane Concentrations Measured at OCOK



[1] A 1-year average is not presented because sampling under the NMP did not begin until May 2009.

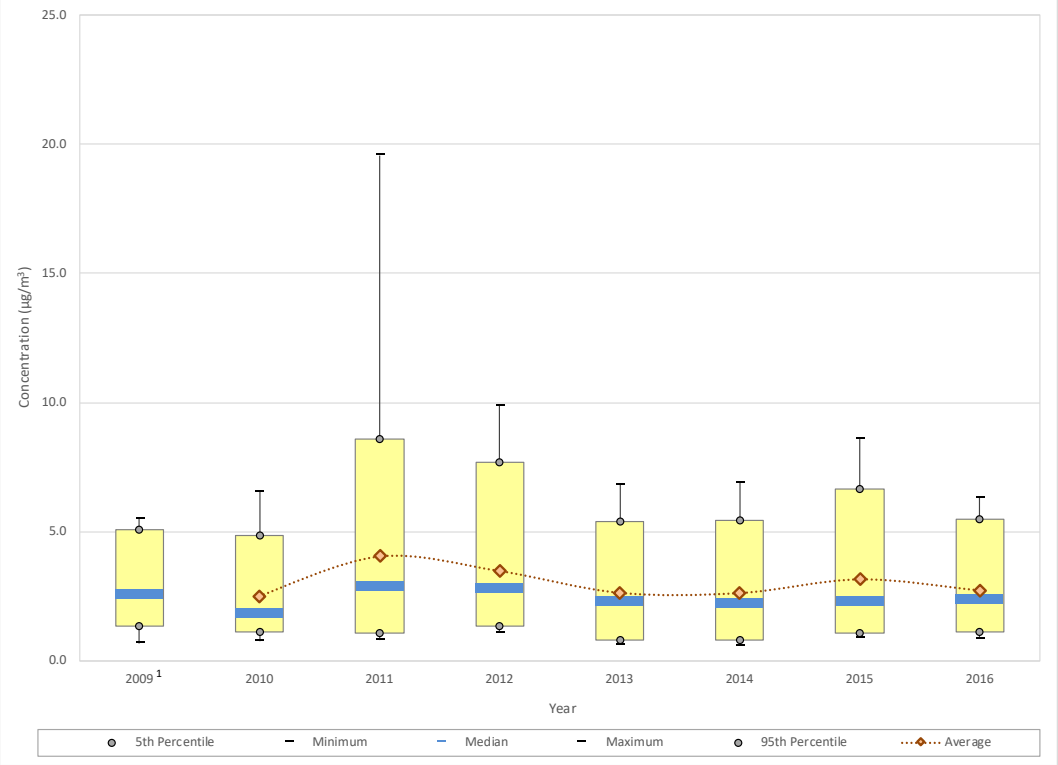
Observations from Figure 18-50 for 1,2-dichloroethane concentrations measured at OCOK include the following:

- The median concentration for 2009, 2010, and 2011 is zero, indicating that at least half of the measurements were non-detects. In 2009, there were four measured detections of 1,2-dichloroethane, which increased gradually through 2011. For 2012, the number of measured detections increased by a factor of four (up to 52). The number of measured detections is greater than 50 each year between 2013 and 2016.

- The increase in measured detections results in an increase in the 1-year average concentrations shown through 2012. Less than 0.01 µg/m^3 separates the 1-year average concentrations calculated for each year between 2012 and 2016; 0.01 µg/m^3 separates the median concentrations calculated for these years.

- The range within which most of the concentrations fall, as indicated by the 5th and 95th percentiles, changed little between 2010 and 2016, even with the percentage of measured detections increasing to more than 90 percent during the last two years of sampling.

Figure 18-51. Yearly Statistical Metrics for Formaldehyde Concentrations Measured at OCOK



[1] A 1-year average is not presented because sampling under the NMP did not begin until May 2009.

Observations from Figure 18-51 for formaldehyde concentrations measured at OCOK include the following:

- The maximum formaldehyde concentration was measured at OCOK on May 9, 2011 (19.6 µg/m^3), the same day as the maximum acetaldehyde concentration was measured; the only other concentration greater than 10 µg/m^3 was also measured at OCOK in 2011 (10.6 µg/m^3). In total, 20 formaldehyde concentrations greater than 7 µg/m^3 were measured at OCOK, with more than half (11) measured in 2011 (and six in 2012 and three in 2015).

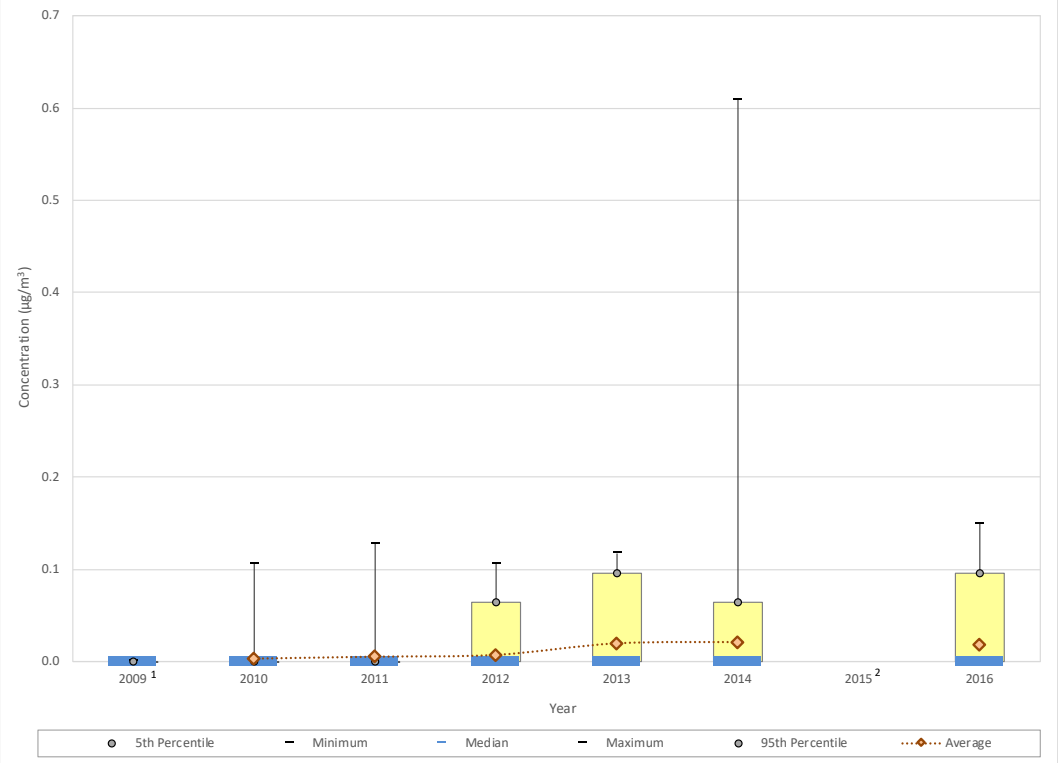
- With the exception of the 5th percentile, all of the statistical parameters exhibit an increase from 2010 to 2011. This is not just a result of the two highest concentrations measured in 2011, as concentrations were higher overall. Twelve concentrations

measured in 2011 were greater than the maximum concentration measured in 2010. The median concentration increased by more than 1 µg/m^3 and the 1-year average concentration increased by more than 60 percent for 2011.

- Formaldehyde concentrations measured after 2011 have a decreasing trend through 2014, though there is little difference shown in the concentration profiles for 2013 and 2014.

- Each of the statistical parameters exhibits an increase for 2015. The maximum, 95th percentile, and 1-year average concentration return to 2014 levels for 2016 while the 5th percentile and minimum concentration change little and the median exhibits further (albeit slight) increases.

Figure 18-52. Yearly Statistical Metrics for Hexachloro-1,3-butadiene Concentrations Measured at OCOK



[1] A 1-year average is not presented because sampling under the NMP did not begin until May 2009.
[2] A concentration profile is not presented due to a laboratory contamination issue affecting numerous samples.

Observations from Figure 18-52 for hexachloro-1,3-butadiene concentrations measured at OCOK include the following:

- The use of a contaminated internal standard at the laboratory for Method TO-15 resulted in the invalidation of the hexachloro-1,3-butadiene measurements from early March 2015 through mid-December 2015, as described in Section 2.4.

- There were few measured detections of hexachloro-1,3-butadiene in the first few years of sampling at OCOK. The median concentration is zero for all years of sampling, indicating that at least half of the measurements were non-detects for each year. The number of measured detections has varied from none (in 2009) to as many as 14 (in 2013 and again in 2016).

- One concentration of hexachloro-1,3-butadiene measured at OCOK is greater than the MDL for this pollutant, the maximum concentration measured in 2014 (0.609 µg/m^3). This is the only hexachloro-1,3-butadiene measurement greater than 0.15 µg/m^3 measured at OCOK.

18.4 Additional Risk-Based Screening Evaluations

The following risk-based screening evaluations were conducted to characterize risk related to the air toxics measured at each Oklahoma monitoring site. Refer to Sections 3.2, 3.4.2.3, and 3.4.2.4 for definitions and explanations regarding the various toxicity factors, time frames, and calculations associated with these risk-based screenings.

18.4.1 Cancer Risk and Noncancer Hazard Approximations

For the pollutants of interest for the Oklahoma monitoring sites and where *annual average* concentrations could be calculated, risk was examined by calculating cancer risk and noncancer hazard approximations. These approximations can be used as risk estimates for cancer and noncancer effects attributable to the pollutants of interest. Although the use of these approximations is limited, they may help identify where policy-makers want to shift their air monitoring priorities. Refer to Section 3.4.2.3 for an explanation of how cancer risk and noncancer hazard approximations are calculated and what limitations are associated with them. Annual averages, cancer UREs and/or noncancer RfCs, and cancer risk and noncancer hazard approximations are presented in Table 18-4, where applicable. Cancer risk approximations are presented as probabilities while the noncancer hazard approximations are ratios and thus, unitless values.

Table 18-4. Risk Approximations for the Oklahoma Monitoring Sites

Pollutant	Cancer URE ($\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	2015				2016			
			# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Risk Approximations		# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Risk Approximations	
					Cancer (in-a-million)	Noncancer (HQ)			Cancer (in-a-million)	Noncancer (HQ)
Public Works, Tulsa, Oklahoma - TOOK										
Acetaldehyde	0.0000022	0.009	60/60	2.02 ± 0.21	4.44	0.22	61/61	1.97 ± 0.18	4.34	0.22
Benzene	0.0000078	0.03	59/59	1.09 ± 0.12	8.50	0.04	61/61	1.08 ± 0.13	8.42	0.04
1,3-Butadiene	0.00003	0.002	56/59	0.07 ± 0.01	2.07	0.03	61/61	0.08 ± 0.01	2.50	0.04
Carbon Tetrachloride	0.000006	0.1	59/59	0.61 ± 0.02	3.67	0.01	61/61	0.61 ± 0.02	3.69	0.01
p-Dichlorobenzene	0.000011	0.8	48/59	0.06 ± 0.01	0.61	<0.01	31/61	0.05 ± 0.02	0.51	<0.01
1,2-Dichloroethane	0.000026	2.4	51/59	0.09 ± 0.01	2.40	<0.01	55/61	0.10 ± 0.01	2.63	<0.01
Ethylbenzene	0.0000025	1	59/59	0.40 ± 0.06	1.01	<0.01	61/61	0.47 ± 0.08	1.18	<0.01
Formaldehyde	0.000013	0.0098	60/60	2.84 ± 0.39	36.86	0.29	61/61	3.33 ± 0.39	43.31	0.34
Arsenic (TSP)[a]	0.0043	0.000015	60/60	0.78 ± 0.08	3.37	0.05	61/61	0.89 ± 0.11	3.83	0.06
Manganese (TSP)[a]	--	0.0003	60/60	26.01 ± 3.92	--	0.09	61/61	26.94 ± 4.15	--	0.09
Nickel (TSP)[a]	0.00048	0.00009	60/60	1.95 ± 0.36	0.94	0.02	61/61	2.17 ± 0.75	1.04	0.02

-- = A Cancer URE or Noncancer RfC is not available.

[a] Average concentrations provided below the blue line for this pollutant are presented in ng/m^3 for ease of viewing.

NA = Not available because the criteria for calculating an annual average were not met.

NS = Sampling was not conducted during this time.

NR = Not reportable due to invalidation related to a contaminated internal standard.

Table 18-4. Risk Approximations for the Oklahoma Monitoring Sites (Continued)

Pollutant	Cancer URE ($\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	2015				2016			
			# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Risk Approximations		# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Risk Approximations	
					Cancer (in-a-million)	Noncancer (HQ)			Cancer (in-a-million)	Noncancer (HQ)
Fire Station, Tulsa, Oklahoma - TMOK										
Acetaldehyde	0.0000022	0.009	60/60	1.84 ± 0.19	4.04	0.20	60/60	1.77 ± 0.16	3.89	0.20
Benzene	0.0000078	0.03	60/60	0.84 ± 0.10	6.59	0.03	60/60	0.90 ± 0.12	7.03	0.03
1,3-Butadiene	0.00003	0.002	56/60	0.09 ± 0.02	2.59	0.04	59/60	0.11 ± 0.02	3.30	0.05
Carbon Tetrachloride	0.000006	0.1	60/60	0.62 ± 0.02	3.70	0.01	60/60	0.63 ± 0.02	3.79	0.01
p-Dichlorobenzene	0.000011	0.8	42/60	0.06 ± 0.01	0.64	<0.01	41/60	0.08 ± 0.02	0.85	<0.01
1,2-Dichloroethane	0.000026	2.4	54/60	0.08 ± 0.01	2.20	<0.01	57/60	0.10 ± 0.01	2.64	<0.01
Ethylbenzene	0.0000025	1	60/60	0.32 ± 0.04	0.80	<0.01	60/60	0.44 ± 0.08	1.10	<0.01
Formaldehyde	0.000013	0.0098	60/60	2.71 ± 0.34	35.26	0.28	60/60	3.16 ± 0.41	41.11	0.32
Hexachloro-1,3-butadiene	0.000022	0.09	1/60	NR	NR	NR	18/60	0.03 ± 0.01	0.63	<0.01
Arsenic (TSP) [a]	0.0043	0.000015	59/59	0.64 ± 0.07	2.76	0.04	61/61	0.67 ± 0.08	2.87	0.04

-- = A Cancer URE or Noncancer RfC is not available.

[a] Average concentrations provided below the blue line for this pollutant are presented in ng/m^3 for ease of viewing.

NA = Not available because the criteria for calculating an annual average were not met.

NS = Sampling was not conducted during this time.

NR = Not reportable due to invalidation related to a contaminated internal standard.

Table 18-4. Risk Approximations for the Oklahoma Monitoring Sites (Continued)

Pollutant	Cancer URE ($\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	2015				2016			
			# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Risk Approximations		# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Risk Approximations	
					Cancer (in-a-million)	Noncancer (HQ)			Cancer (in-a-million)	Noncancer (HQ)
Riverside, Tulsa, Oklahoma - TROK										
Acetaldehyde	0.0000022	0.009	59/59	1.92 ± 0.19	4.22	0.21	61/61	2.02 ± 0.19	4.43	0.22
Benzene	0.0000078	0.03	60/60	0.79 ± 0.06	6.17	0.03	61/61	0.89 ± 0.09	6.96	0.03
1,3-Butadiene	0.00003	0.002	58/60	0.07 ± 0.01	2.01	0.03	61/61	0.08 ± 0.01	2.44	0.04
Carbon Tetrachloride	0.000006	0.1	60/60	0.61 ± 0.02	3.65	0.01	61/61	0.60 ± 0.03	3.60	0.01
1,2-Dichloroethane	0.000026	2.4	53/60	0.08 ± 0.01	2.09	<0.01	57/61	0.10 ± 0.01	2.52	<0.01
Ethylbenzene	0.0000025	1	60/60	0.31 ± 0.03	0.78	<0.01	61/61	0.41 ± 0.07	1.02	<0.01
Formaldehyde	0.000013	0.0098	59/59	2.67 ± 0.38	34.71	0.27	61/61	2.92 ± 0.35	37.94	0.30
Hexachloro-1,3-butadiene	0.000022	0.09	1/60	NR	NR	NR	18/61	0.03 ± 0.01	0.60	<0.01
Arsenic (TSP) [a]	0.0043	0.000015	60/60	0.85 ± 0.14	3.64	0.06	61/61	0.95 ± 0.20	4.08	0.06
Nickel (TSP) [a]	0.00048	0.00009	60/60	1.44 ± 0.19	0.69	0.02	61/61	1.20 ± 0.18	0.58	0.01

-- = A Cancer URE or Noncancer RfC is not available.

[a] Average concentrations provided below the blue line for this pollutant are presented in ng/m^3 for ease of viewing.

NA = Not available because the criteria for calculating an annual average were not met.

NS = Sampling was not conducted during this time.

NR = Not reportable due to invalidation related to a contaminated internal standard.

Table 18-4. Risk Approximations for the Oklahoma Monitoring Sites (Continued)

Pollutant	Cancer URE ($\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	2015				2016			
			# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Risk Approximations		# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Risk Approximations	
					Cancer (in-a-million)	Noncancer (HQ)			Cancer (in-a-million)	Noncancer (HQ)
Oklahoma City, Oklahoma - OCOK										
Acetaldehyde	0.0000022	0.009	60/60	1.92 ± 0.22	4.23	0.21	60/60	1.63 ± 0.14	3.59	0.18
Benzene	0.0000078	0.03	60/60	0.58 ± 0.04	4.52	0.02	61/61	0.61 ± 0.11	4.75	0.02
1,3-Butadiene	0.00003	0.002	50/60	0.04 ± 0.01	1.14	0.02	54/61	0.05 ± 0.01	1.37	0.02
Carbon Tetrachloride	0.000006	0.1	60/60	0.64 ± 0.02	3.81	0.01	61/61	0.61 ± 0.03	3.68	0.01
1,2-Dichloroethane	0.000026	2.4	56/60	0.08 ± 0.01	1.99	<0.01	55/61	0.07 ± 0.01	1.89	<0.01
Formaldehyde	0.000013	0.0098	60/60	3.16 ± 0.50	41.05	0.32	60/60	2.72 ± 0.37	35.41	0.28
Hexachloro-1,3-butadiene	0.000022	0.09	5/60	NR	NR	NR	14/61	0.02 ± 0.01	0.41	<0.01
Arsenic (TSP) [a]	0.0043	0.000015	60/60	0.56 ± 0.07	2.39	0.04	60/60	0.51 ± 0.06	2.21	0.03

-- = A Cancer URE or Noncancer RfC is not available.

[a] Average concentrations provided below the blue line for this pollutant are presented in ng/m^3 for ease of viewing.

NA = Not available because the criteria for calculating an annual average were not met.

NS = Sampling was not conducted during this time.

NR = Not reportable due to invalidation related to a contaminated internal standard.

Table 18-4. Risk Approximations for the Oklahoma Monitoring Sites (Continued)

Pollutant	Cancer URE ($\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	2015				2016			
			# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Risk Approximations		# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Risk Approximations	
					Cancer (in-a-million)	Noncancer (HQ)			Cancer (in-a-million)	Noncancer (HQ)
Near-road, Oklahoma City, Oklahoma – NROK										
Acetaldehyde	0.0000022	0.009	NS	NS	NS	NS	38/38	NA	NA	NA
Benzene	0.0000078	0.03	NS	NS	NS	NS	38/38	NA	NA	NA
1,3-Butadiene	0.00003	0.002	NS	NS	NS	NS	38/38	NA	NA	NA
Carbon Tetrachloride	0.000006	0.1	NS	NS	NS	NS	38/38	NA	NA	NA
p-Dichlorobenzene	0.000011	0.8	NS	NS	NS	NS	32/38	NA	NA	NA
1,2-Dichloroethane	0.000026	2.4	NS	NS	NS	NS	32/38	NA	NA	NA
Ethylbenzene	0.0000025	1	NS	NS	NS	NS	38/38	NA	NA	NA
Formaldehyde	0.000013	0.0098	NS	NS	NS	NS	38/38	NA	NA	NA

-- = A Cancer URE or Noncancer RfC is not available.

[a] Average concentrations provided below the blue line for this pollutant are presented in ng/m^3 for ease of viewing.

NA = Not available because the criteria for calculating an annual average were not met.

NS = Sampling was not conducted during this time.

NR = Not reportable due to invalidation related to a contaminated internal standard.

Table 18-4. Risk Approximations for the Oklahoma Monitoring Sites (Continued)

Pollutant	Cancer URE ($\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	2015				2016			
			# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Risk Approximations		# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Risk Approximations	
					Cancer (in-a-million)	Noncancer (HQ)			Cancer (in-a-million)	Noncancer (HQ)
Yukon, Oklahoma – YUOK										
Acetaldehyde	0.0000022	0.009	59/59	1.64 ± 0.16	3.61	0.18	61/61	1.60 ± 0.13	3.51	0.18
Benzene	0.0000078	0.03	59/59	0.56 ± 0.07	4.34	0.02	61/61	0.52 ± 0.05	4.07	0.02
1,3-Butadiene	0.00003	0.002	51/59	0.04 ± 0.01	1.16	0.02	57/61	0.04 ± 0.01	1.21	0.02
Carbon Tetrachloride	0.000006	0.1	59/59	0.62 ± 0.03	3.71	0.01	61/61	0.61 ± 0.02	3.64	0.01
1,2-Dichloroethane	0.000026	2.4	57/59	0.08 ± 0.01	2.03	<0.01	57/61	0.08 ± 0.01	1.96	<0.01
Formaldehyde	0.000013	0.0098	59/59	2.71 ± 0.39	35.20	0.28	61/61	2.64 ± 0.37	34.32	0.27
Hexachloro-1,3-butadiene	0.000022	0.09	2/59	NR	NR	NR	13/61	0.02 ± 0.01	0.37	<0.01
Arsenic (TSP) [a]	0.0043	0.000015	59/59	0.55 ± 0.09	2.38	0.04	61/61	0.54 ± 0.08	2.34	0.04

-- = A Cancer URE or Noncancer RfC is not available.

[a] Average concentrations provided below the blue line for this pollutant are presented in ng/m^3 for ease of viewing.

NA = Not available because the criteria for calculating an annual average were not met.

NS = Sampling was not conducted during this time.

NR = Not reportable due to invalidation related to a contaminated internal standard.

Table 18-4. Risk Approximations for the Oklahoma Monitoring Sites (Continued)

Pollutant	Cancer URE ($\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	2015				2016			
			# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Risk Approximations		# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Risk Approximations	
					Cancer (in-a-million)	Noncancer (HQ)			Cancer (in-a-million)	Noncancer (HQ)
Bradley, Oklahoma – BROK										
Acetaldehyde	0.0000022	0.009	40/40	4.06 ± 1.42	8.93	0.45	60/60	1.46 ± 0.14	3.22	0.16
Benzene	0.0000078	0.03	39/39	NA	NA	NA	59/59	0.80 ± 0.10	6.23	0.03
1,3-Butadiene	0.00003	0.002	29/39	NA	NA	NA	45/59	0.02 ± <0.01	0.68	0.01
Carbon Tetrachloride	0.000006	0.1	39/39	NA	NA	NA	59/59	0.59 ± 0.04	3.55	0.01
1,2-Dichloroethane	0.000026	2.4	34/39	NA	NA	NA	56/59	0.09 ± 0.01	2.43	<0.01
Formaldehyde	0.000013	0.0098	40/40	4.95 ± 1.59	64.31	0.50	60/60	2.07 ± 0.30	26.97	0.21
Propionaldehyde	--	0.008	40/40	1.01 ± 0.42	--	0.13	60/60	0.33 ± 0.03	--	0.04

-- = A Cancer URE or Noncancer RfC is not available.

[a] Average concentrations provided below the blue line for this pollutant are presented in ng/m^3 for ease of viewing.

NA = Not available because the criteria for calculating an annual average were not met.

NS = Sampling was not conducted during this time.

NR = Not reportable due to invalidation related to a contaminated internal standard.

Observations from Table 18-4 include the following:

- Formaldehyde and acetaldehyde have the highest annual average concentrations for each site.

- Formaldehyde and benzene have the highest cancer risk approximations among the pollutants of interest for each Oklahoma monitoring site, with one exception (2015, when annual averages could not be calculated for the VOC pollutants of interest for BROK). Cancer risk approximations for formaldehyde range from 26.97 in-a-million (BROK, 2016) to 64.31 in-a-million (BROK, 2015). BROK's 2015 cancer risk approximation for formaldehyde ranks sixth highest among all cancer risk approximations program-wide. Benzene cancer risk approximations for the Oklahoma monitoring sites range from 4.07 in-a-million (YUOK, 2016) to 8.50 in-a-million (TOOK, 2015). BROK's cancer risk approximation for acetaldehyde for 2015 is 8.93 in-a-million; remaining cancer risk approximations for acetaldehyde are less than 5 in-a-million, ranging from 3.22 in-a-million for BROK (2015) to 4.44 in-a-million for TOOK (2015).

- None of the pollutants of interest for the Oklahoma sites have noncancer hazard approximations greater than 1.0, indicating that no adverse noncancer health effects are expected from these individual pollutants. The highest noncancer hazard approximation calculated was based on BROK's annual average concentration of formaldehyde for 2015 (0.50).

18.4.2 Risk-Based Emissions Assessment

In addition to the risk-based screening discussed above, this section presents an evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 18-5 presents the 10 pollutants with the highest emissions from the 2014 NEI (version 1) that have cancer toxicity factors. Table 18-5 also presents the 10 pollutants with the highest toxicity-weighted emissions, based on the weighting schema described in Section 3.4.2.4. Lastly, Table 18-5 provides the pollutants with the highest cancer risk approximations (in-a-million) for each site, as presented in Table 18-4. Cancer risk approximations for 2015 are presented in green while approximations for 2016 are in white. The emissions, toxicity-weighted emissions, and cancer risk approximations are shown in descending order in Table 18-5. Table 18-6 presents similar information, but is limited to those pollutants with noncancer toxicity factors.

Table 18-5. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Oklahoma Monitoring Sites

Top 10 Total Emissions for Pollutants with Cancer UREs (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Public Works, Tulsa, Oklahoma (Tulsa County) - TOOK					
Benzene	260.73	Hexavalent Chromium, PM	2.47E-03	Formaldehyde	43.31
Formaldehyde	185.06	Formaldehyde	2.41E-03	Formaldehyde	36.86
Ethylbenzene	162.19	Benzene	2.03E-03	Benzene	8.50
Acetaldehyde	101.70	Naphthalene	1.21E-03	Benzene	8.42
1,3-Butadiene	35.95	1,3-Butadiene	1.08E-03	Acetaldehyde	4.44
Naphthalene	35.51	Ethylbenzene	4.05E-04	Acetaldehyde	4.34
Tetrachloroethylene	14.79	POM, Group 2b	3.62E-04	Arsenic	3.83
Trichloroethylene	10.43	POM, Group 5a	2.84E-04	Carbon Tetrachloride	3.69
POM, Group 2b	4.12	POM, Group 2d	2.74E-04	Carbon Tetrachloride	3.67
POM, Group 2d	3.11	Nickel, PM	2.49E-04	Arsenic	3.37
Fire Station, Tulsa, Oklahoma (Tulsa County) - TMOK					
Benzene	260.73	Hexavalent Chromium, PM	2.47E-03	Formaldehyde	41.11
Formaldehyde	185.06	Formaldehyde	2.41E-03	Formaldehyde	35.26
Ethylbenzene	162.19	Benzene	2.03E-03	Benzene	7.03
Acetaldehyde	101.70	Naphthalene	1.21E-03	Benzene	6.59
1,3-Butadiene	35.95	1,3-Butadiene	1.08E-03	Acetaldehyde	4.04
Naphthalene	35.51	Ethylbenzene	4.05E-04	Acetaldehyde	3.89
Tetrachloroethylene	14.79	POM, Group 2b	3.62E-04	Carbon Tetrachloride	3.79
Trichloroethylene	10.43	POM, Group 5a	2.84E-04	Carbon Tetrachloride	3.70
POM, Group 2b	4.12	POM, Group 2d	2.74E-04	1,3-Butadiene	3.30
POM, Group 2d	3.11	Nickel, PM	2.49E-04	Arsenic	2.87

[1]Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Table 18-5. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Oklahoma Monitoring Sites (Continued)

Top 10 Total Emissions for Pollutants with Cancer UREs (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Riverside, Tulsa, Oklahoma (Tulsa County) - TROK					
Benzene	260.73	Hexavalent Chromium, PM	2.47E-03	Formaldehyde	37.94
Formaldehyde	185.06	Formaldehyde	2.41E-03	Formaldehyde	34.71
Ethylbenzene	162.19	Benzene	2.03E-03	Benzene	6.96
Acetaldehyde	101.70	Naphthalene	1.21E-03	Benzene	6.17
1,3-Butadiene	35.95	1,3-Butadiene	1.08E-03	Acetaldehyde	4.43
Naphthalene	35.51	Ethylbenzene	4.05E-04	Acetaldehyde	4.22
Tetrachloroethylene	14.79	POM, Group 2b	3.62E-04	Arsenic	4.08
Trichloroethylene	10.43	POM, Group 5a	2.84E-04	Carbon Tetrachloride	3.65
POM, Group 2b	4.12	POM, Group 2d	2.74E-04	Arsenic	3.64
POM, Group 2d	3.11	Nickel, PM	2.49E-04	Carbon Tetrachloride	3.60
Oklahoma City, Oklahoma (Oklahoma County) - OCOK					
Benzene	303.27	Formaldehyde	3.54E-03	Formaldehyde	41.05
Formaldehyde	272.57	Benzene	2.37E-03	Formaldehyde	35.41
Ethylbenzene	178.49	Naphthalene	1.52E-03	Benzene	4.75
Acetaldehyde	138.18	1,3-Butadiene	1.26E-03	Benzene	4.52
Naphthalene	44.62	Hexavalent Chromium, PM	7.60E-04	Acetaldehyde	4.23
1,3-Butadiene	42.06	POM, Group 2b	5.31E-04	Carbon Tetrachloride	3.81
Dichloromethane	15.53	Ethylbenzene	4.46E-04	Carbon Tetrachloride	3.68
POM, Group 2b	6.03	POM, Group 2d	3.32E-04	Acetaldehyde	3.59
POM, Group 2d	3.78	Acetaldehyde	3.04E-04	Arsenic	2.39
Trichloroethylene	3.12	POM, Group 5a	2.92E-04	Arsenic	2.21

[1]Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Table 18-5. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Oklahoma Monitoring Sites (Continued)

Top 10 Total Emissions for Pollutants with Cancer UREs (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Near-road, Oklahoma City, Oklahoma (Oklahoma County) - NROK					
Benzene	303.27	Formaldehyde	3.54E-03		
Formaldehyde	272.57	Benzene	2.37E-03		
Ethylbenzene	178.49	Naphthalene	1.52E-03		
Acetaldehyde	138.18	1,3-Butadiene	1.26E-03		
Naphthalene	44.62	Hexavalent Chromium, PM	7.60E-04		
1,3-Butadiene	42.06	POM, Group 2b	5.31E-04		
Dichloromethane	15.53	Ethylbenzene	4.46E-04		
POM, Group 2b	6.03	POM, Group 2d	3.32E-04		
POM, Group 2d	3.78	Acetaldehyde	3.04E-04		
Trichloroethylene	3.12	POM, Group 5a	2.92E-04		
Yukon, Oklahoma (Canadian County) - YUOK					
Formaldehyde	267.69	Formaldehyde	3.48E-03	Formaldehyde	35.20
Acetaldehyde	120.19	Benzene	6.63E-04	Formaldehyde	34.32
Benzene	84.96	1,3-Butadiene	3.59E-04	Benzene	4.34
Ethylbenzene	24.98	Acetaldehyde	2.64E-04	Benzene	4.07
1,3-Butadiene	11.96	Naphthalene	2.48E-04	Carbon Tetrachloride	3.71
Naphthalene	7.30	POM, Group 2b	7.57E-05	Carbon Tetrachloride	3.64
POM, Group 2b	0.86	POM, Group 1a	7.12E-05	Acetaldehyde	3.61
POM, Group 1a	0.81	POM, Group 2d	6.51E-05	Acetaldehyde	3.51
POM, Group 2d	0.74	Ethylbenzene	6.24E-05	Arsenic	2.38
Dichloromethane	0.69	1,2-Dibromoethane	6.05E-05	Arsenic	2.34

[1]Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Table 18-5. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Oklahoma Monitoring Sites (Continued)

Top 10 Total Emissions for Pollutants with Cancer UREs (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Bradley, Oklahoma (Grady County) - BROK					
Formaldehyde	273.26	Formaldehyde	3.55E-03	Formaldehyde	64.31
Acetaldehyde	67.50	Benzene	4.32E-04	Formaldehyde	26.97
Benzene	55.36	1,3-Butadiene	2.98E-04	Acetaldehyde	8.93
Ethylbenzene	17.11	Acetaldehyde	1.49E-04	Benzene	6.23
1,3-Butadiene	9.95	Naphthalene	1.35E-04	Carbon Tetrachloride	3.55
Naphthalene	3.97	POM, Group 1a	7.01E-05	Acetaldehyde	3.22
Dichloromethane	0.88	1,2-Dibromoethane	6.76E-05	1,2-Dichloroethane	2.43
POM, Group 1a	0.80	POM, Group 2b	5.25E-05	1,3-Butadiene	0.68
POM, Group 2b	0.60	POM, Group 2d	4.51E-05		
POM, Group 2d	0.51	Ethylbenzene	4.28E-05		

[1]Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Table 18-6. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the Oklahoma Monitoring Sites

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Hazard Approximation (HQ)**
Public Works, Tulsa, Oklahoma (Tulsa County) - TOOK					
Toluene	1,035.38	Acrolein	732,286.29	Formaldehyde	0.34
Xylenes	598.49	Formaldehyde	18,883.99	Formaldehyde	0.29
Methanol	318.54	1,3-Butadiene	17,975.67	Acetaldehyde	0.22
Hexane	269.09	Naphthalene	11,836.01	Acetaldehyde	0.22
Benzene	260.73	Acetaldehyde	11,299.58	Manganese	0.09
Formaldehyde	185.06	Benzene	8,691.01	Manganese	0.09
Ethylbenzene	162.19	Xylenes	5,984.91	Arsenic	0.06
Ethylene glycol	107.55	Nickel, PM	5,760.01	Arsenic	0.05
Acetaldehyde	101.70	Trichloroethylene	5,215.94	1,3-Butadiene	0.04
Hydrofluoric acid	48.54	Cadmium, PM	4,820.24	Benzene	0.04
Fire Station, Tulsa, Oklahoma (Tulsa County) - TMOK					
Toluene	1,035.38	Acrolein	732,286.29	Formaldehyde	0.32
Xylenes	598.49	Formaldehyde	18,883.99	Formaldehyde	0.28
Methanol	318.54	1,3-Butadiene	17,975.67	Acetaldehyde	0.20
Hexane	269.09	Naphthalene	11,836.01	Acetaldehyde	0.20
Benzene	260.73	Acetaldehyde	11,299.58	1,3-Butadiene	0.05
Formaldehyde	185.06	Benzene	8,691.01	Arsenic	0.04
Ethylbenzene	162.19	Xylenes	5,984.91	1,3-Butadiene	0.04
Ethylene glycol	107.55	Nickel, PM	5,760.01	Arsenic	0.04
Acetaldehyde	101.70	Trichloroethylene	5,215.94	Benzene	0.03
Hydrofluoric acid	48.54	Cadmium, PM	4,820.24	Benzene	0.03

[1]Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Table 18-6. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the Oklahoma Monitoring Sites (Continued)

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Hazard Approximation (HQ)**
Riverside, Tulsa, Oklahoma (Tulsa County) - TROK					
Toluene	1,035.38	Acrolein	732,286.29	Formaldehyde	0.30
Xylenes	598.49	Formaldehyde	18,883.99	Formaldehyde	0.27
Methanol	318.54	1,3-Butadiene	17,975.67	Acetaldehyde	0.22
Hexane	269.09	Naphthalene	11,836.01	Acetaldehyde	0.21
Benzene	260.73	Acetaldehyde	11,299.58	Arsenic	0.06
Formaldehyde	185.06	Benzene	8,691.01	Arsenic	0.06
Ethylbenzene	162.19	Xylenes	5,984.91	1,3-Butadiene	0.04
Ethylene glycol	107.55	Nickel, PM	5,760.01	1,3-Butadiene	0.03
Acetaldehyde	101.70	Trichloroethylene	5,215.94	Benzene	0.03
Hydrofluoric acid	48.54	Cadmium, PM	4,820.24	Benzene	0.03
Oklahoma City, Oklahoma (Oklahoma County) - OCOK					
Toluene	1,155.76	Acrolein	1,388,820.96	Formaldehyde	0.32
Xylenes	678.98	Formaldehyde	27,813.75	Formaldehyde	0.28
Methanol	390.58	1,3-Butadiene	21,030.79	Acetaldehyde	0.21
Hexane	374.93	Acetaldehyde	15,353.68	Acetaldehyde	0.18
Benzene	303.27	Naphthalene	14,874.92	Arsenic	0.04
Formaldehyde	272.57	Benzene	10,109.02	Arsenic	0.03
Ethylbenzene	178.49	Xylenes	6,789.78	1,3-Butadiene	0.02
Ethylene glycol	143.51	Cyanide Compounds, gas	2,746.37	Benzene	0.02
Acetaldehyde	138.18	Nickel, PM	2,204.08	Benzene	0.02
Naphthalene	44.62	Glycol ethers, gas	2,109.68	1,3-Butadiene	0.02

[1]Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Table 18-6. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the Oklahoma Monitoring Sites (Continued)

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Hazard Approximation (HQ)**
Near-road, Oklahoma City, Oklahoma (Oklahoma County) - NROK					
Toluene	1,155.76	Acrolein	1,388,820.96		
Xylenes	678.98	Formaldehyde	27,813.75		
Methanol	390.58	1,3-Butadiene	21,030.79		
Hexane	374.93	Acetaldehyde	15,353.68		
Benzene	303.27	Naphthalene	14,874.92		
Formaldehyde	272.57	Benzene	10,109.02		
Ethylbenzene	178.49	Xylenes	6,789.78		
Ethylene glycol	143.51	Cyanide Compounds, gas	2,746.37		
Acetaldehyde	138.18	Nickel, PM	2,204.08		
Naphthalene	44.62	Glycol ethers, gas	2,109.68		
Yukon, Oklahoma (Canadian County) - YUOK					
Formaldehyde	267.69	Acrolein	3,787,368.55	Formaldehyde	0.28
Xylenes	219.21	Formaldehyde	27,315.35	Formaldehyde	0.27
Toluene	170.13	Acetaldehyde	13,354.33	Acetaldehyde	0.18
Methanol	126.11	1,3-Butadiene	5,982.12	Acetaldehyde	0.18
Acetaldehyde	120.19	Benzene	2,832.09	Arsenic	0.04
Benzene	84.96	Naphthalene	2,434.57	Arsenic	0.04
Acrolein	75.75	Xylenes	2,192.08	1,3-Butadiene	0.02
Hexane	61.45	Cyanide Compounds, gas	1,665.91	1,3-Butadiene	0.02
Ethylbenzene	24.98	Lead, PM	1,020.81	Benzene	0.02
Ethylene glycol	21.49	Cadmium, PM	530.43	Benzene	0.02

[1]Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Table 18-6. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the Oklahoma Monitoring Sites (Continued)

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific)	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Hazard Approximation (HQ)**
Bradley, Oklahoma (Grady County) - BROK					
Formaldehyde	273.26	Acrolein	1,867,435.12	Formaldehyde	0.50
Xylenes	167.13	Formaldehyde	27,884.14	Acetaldehyde	0.45
Toluene	118.51	Acetaldehyde	7,500.28	Formaldehyde	0.21
Acetaldehyde	67.50	1,3-Butadiene	4,974.14	Acetaldehyde	0.16
Methanol	56.81	Cobalt , PM	2,066.54	Propionaldehyde	0.13
Benzene	55.36	Cyanide Compounds, gas	1,965.13	Propionaldehyde	0.04
Acrolein	37.35	Benzene	1,845.35	Benzene	0.03
Styrene	35.75	Xylenes	1,671.27	1,3-Butadiene	0.01
Hexane	35.64	Naphthalene	1,324.08	Carbon Tetrachloride	0.01
Ethylbenzene	17.11	Propionaldehyde	283.01	1,2-Dichloroethane	<0.01

[1]Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Because not all pollutants have both cancer and noncancer toxicity factors, the highest emitted pollutants in the cancer table may be different from the noncancer table, although the actual quantity of emissions is the same. The cancer risk and noncancer hazard approximations based on each site's annual averages are limited to the pollutants of interest identified for each site. In addition, the cancer risk and noncancer hazard approximations are limited to those pollutants with enough data to meet the criteria for annual averages to be calculated. A more in-depth discussion of this analysis is provided in Section 3.4.2.4. Similar to the cancer risk and noncancer hazard approximations provided in Section 18.4.1, this analysis may help policy-makers prioritize their air monitoring activities.

Observations from Table 18-5 include the following:

- Benzene is the highest emitted pollutant with a cancer URE in Tulsa and Oklahoma Counties, followed by formaldehyde and ethylbenzene. The highest emitted pollutants in Canadian and Grady Counties are formaldehyde, acetaldehyde, and benzene.

- The pollutant with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) for Tulsa County is hexavalent chromium, followed by formaldehyde and benzene. The pollutant with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) for Oklahoma County is formaldehyde, followed by benzene and naphthalene. The pollutant with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) for Canadian and Grady Counties is also formaldehyde, followed by benzene and 1,3-butadiene.

- Seven of the highest emitted pollutants in Tulsa County also have the highest toxicity-weighted emissions. Eight of the highest emitted pollutants in Oklahoma County also have the highest toxicity-weighted emissions. Nine of the highest emitted pollutants in Canadian County also have the highest toxicity-weighted emissions; this is also true for Grady County.

- With the exception of BROK, formaldehyde and benzene have the highest cancer risk approximations among the Oklahoma sites' pollutants of interest. Both of these pollutants appear at or near the top of both emissions-based lists for each county. Acetaldehyde also appears among the pollutants with the highest cancer risk approximations for each Oklahoma site; acetaldehyde is one of the pollutants listed in both emissions-based lists for Oklahoma, Canadian, and Grady Counties, but is not among the pollutants with the highest toxicity-weighted emissions for Tulsa County (it ranks 11th, though).

- Arsenic is a pollutant of interest for each of the five sites sampling TSP metals. Although this pollutant has one of the higher cancer risk approximations for each site, arsenic is not on either emissions-based list for these four counties.

- Carbon tetrachloride is another pollutant of interest for each site and has some of the higher cancer risk approximations for each site but does not appear on either emissions-based list for any of the Oklahoma counties with an NMP site.

- Naphthalene and several POM Groups appear in Table 18-5 for quantity emitted and toxicity-weighted emissions. PAHs were not sampled for under the NMP at the Oklahoma sites.

Observations from Table 18-6 include the following:

- Toluene and xylenes are the highest emitted pollutants with noncancer RfCs in Tulsa and Oklahoma Counties, while the formaldehyde and xylenes are the highest emitted pollutants with noncancer RfCs in Canadian and Grady Counties. Emissions were considerably higher in Tulsa and Oklahoma Counties than Canadian and Grady Counties.

- Acrolein is the pollutant with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) for all four Oklahoma counties. Acrolein has the highest toxicity-weighted emissions for almost all counties with NMP sites but appears among the highest emitted for only five. Canadian and Grady Counties are two of those counties, with acrolein ranking seventh among those with the highest emissions for each county. Compared to other counties with NMP sites, Canadian County's acrolein emissions rank fourth highest (75.75 tpy) and Grady County's rank seventh highest (37.35 tpy) among counties with NMP sites (acrolein emissions in Oklahoma and Tulsa Counties are 27.78 tpy and 14.65 tpy, respectively). Acrolein was sampled for at all seven Oklahoma sites, but this pollutant was excluded from the pollutants of interest designation, and thus subsequent risk-based screening evaluations, due to questions about the consistency and reliability of the measurements, as discussed in Section 3.2.

- Four of the highest emitted pollutants in Tulsa County also have the highest toxicity-weighted emissions; five of the highest emitted pollutants in Oklahoma, Canadian, and Grady Counties also have the highest toxicity-weighted emissions. Even though toluene is one of, if not the highest emitted pollutant in all four counties, this pollutant does not appear among those with the highest toxicity-weighted emissions.

- Formaldehyde and acetaldehyde have the highest noncancer hazard approximations among the Oklahoma sites, where they could be calculated. These pollutants appear on both emissions-based lists for each county. Benzene also appears on all three lists for each site. 1,3-Butadiene also has some of the highest noncancer hazard approximations for each site, and has some of the highest toxicity-weighted emissions for each respective county, but is not one of the 10 highest emitted pollutants in each county (but is just outside the list at 11th or 12th highest for each county).

- Arsenic appears among the pollutants with the highest noncancer hazard approximations for TOOK, TMOK, TROK, OCOK, and YUOK, but appears on neither emissions-based list for the four Oklahoma Counties. At least one metal appears among the pollutants with the highest toxicity-weighted emissions for each

county, but no metals are listed among the highest emitted pollutants for any of the counties. This speaks to the relative toxicity of the speciated metals.

18.5 Summary of the 2015-2016 Monitoring Data for the Oklahoma Monitoring Sites

Results from several of the data analyses described in this section include the following:

- *Seventeen pollutants failed at least one screen for TOOK; 17 pollutants failed screens for TMOK; 17 pollutants failed screens for TROK; 16 pollutants failed screens for OCOK; 10 pollutants failed screens for NROK; 15 pollutants failed screens for YUOK; and 11 pollutants failed screens for BROK.*

- *Formaldehyde and acetaldehyde had the highest annual average concentrations for each site. BROK's annual average concentration of acetaldehyde for 2015 is the highest annual average among NMP sites sampling this pollutant, although BROK's annual average for 2016 is significantly lower.*

- *After several years of increasing, concentrations of several pollutants, including acetaldehyde, benzene, ethylbenzene, and manganese, decreased at TOOK after 2012 then have remained fairly static in recent years. Other pollutants exhibit this trend as well but the difference is less significant. Benzene and acetaldehyde concentrations have also been decreasing at TMOK and have also leveled out in recent years. In addition, the detection rates of 1,2-dichloroethane have been increasing at TOOK, TMOK, and OCOK over the last five years of sampling.*

- *Formaldehyde has the highest cancer risk approximation among the site-specific pollutants of interest for each site. None of the pollutants of interest have noncancer hazard approximations greater than an HQ of 1.0.*

19.0 Site in Rhode Island

This section summarizes those data from samples collected at the NATTS site in Rhode Island and generated by ERG, EPA's contract laboratory for the NMP, over the 2015 and 2016 monitoring efforts. This section also examines the spatial and temporal characteristics of the ambient monitoring concentrations and reviews them through the context of risk. Readers are encouraged to refer to Sections 1 through 4 for detailed discussions and definitions regarding the various data analyses presented below.

Data generated by sources other than ERG, EPA's contract laboratory for the NMP, are not included in the data analyses contained in this report.

19.1 Site Characterization

This section characterizes the Rhode Island monitoring site by providing a description of the nearby area surrounding the monitoring site; plotting emissions sources surrounding the monitoring site; and presenting traffic data and other characterizing information for the site. This information is provided to give the reader insight regarding factors that may influence the air quality near the site and assist in the interpretation of the ambient measurements.

The PRRI monitoring site is located in south Providence. Figure 19-1 presents a composite satellite image retrieved from ArcGIS Explorer showing the monitoring site and its immediate surroundings. Figure 19-2 identifies nearby point source emissions locations by source category, as reported in the 2014 NEI for point sources, version 1. Note that only sources within 10 miles of the site are included in the facility counts provided in Figure 19-2. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have a direct effect on the air quality at the monitoring site. Further, this boundary provides both the proximity of emissions sources to the monitoring site as well as the quantity of such sources within a given distance of the site. Sources outside the 10-mile boundary are still visible on the map for reference but have been grayed out to emphasize emissions sources within the boundary. Table 19-1 provides supplemental geographical information such as land use, location setting, and locational coordinates. Each figure and table is discussed in detail in the paragraphs that follow.

Figure 19-1. Providence, Rhode Island (PRRI) Monitoring Site

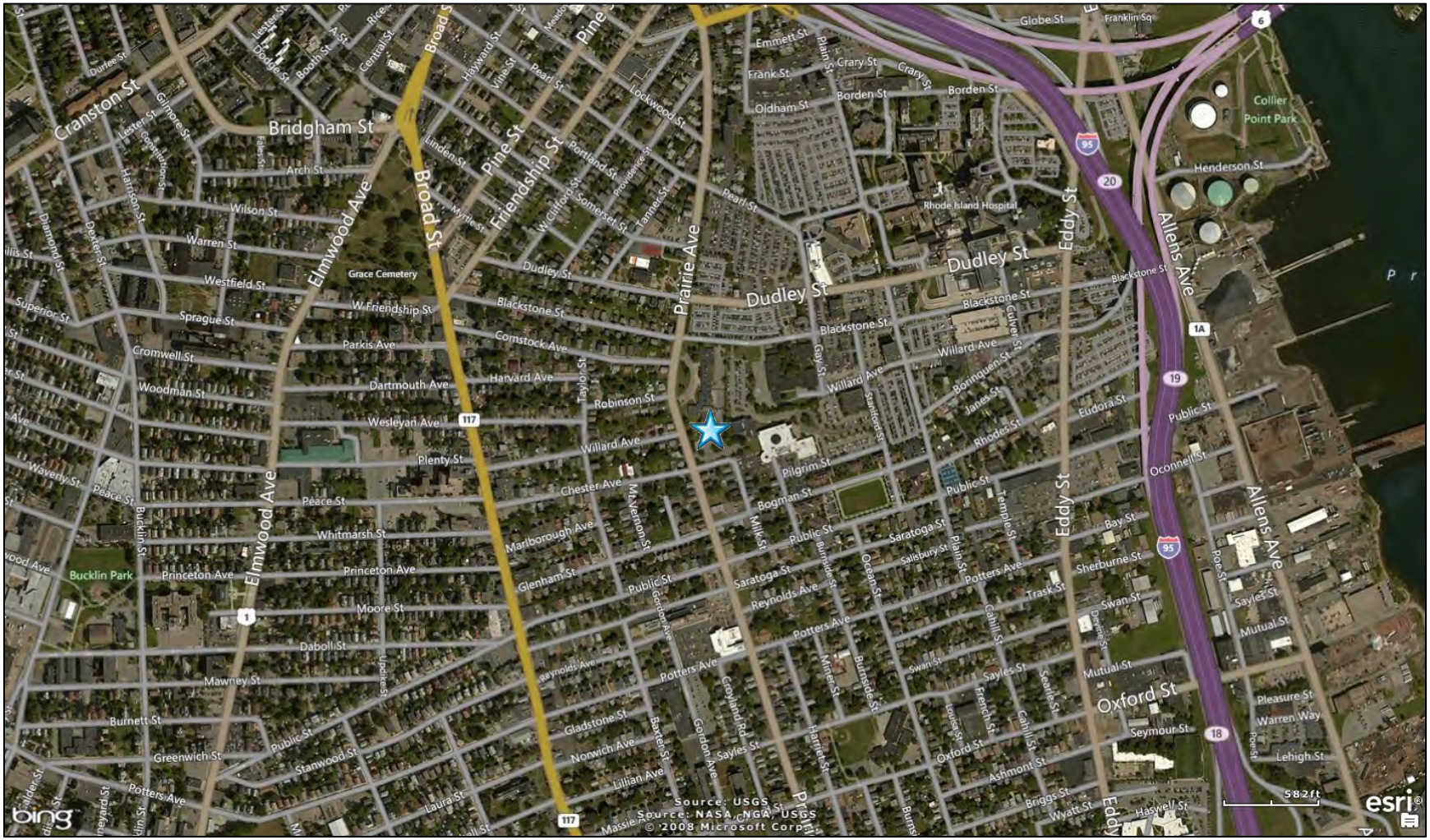


Figure 19-2. NEI Point Sources Located Within 10 Miles of PRRI

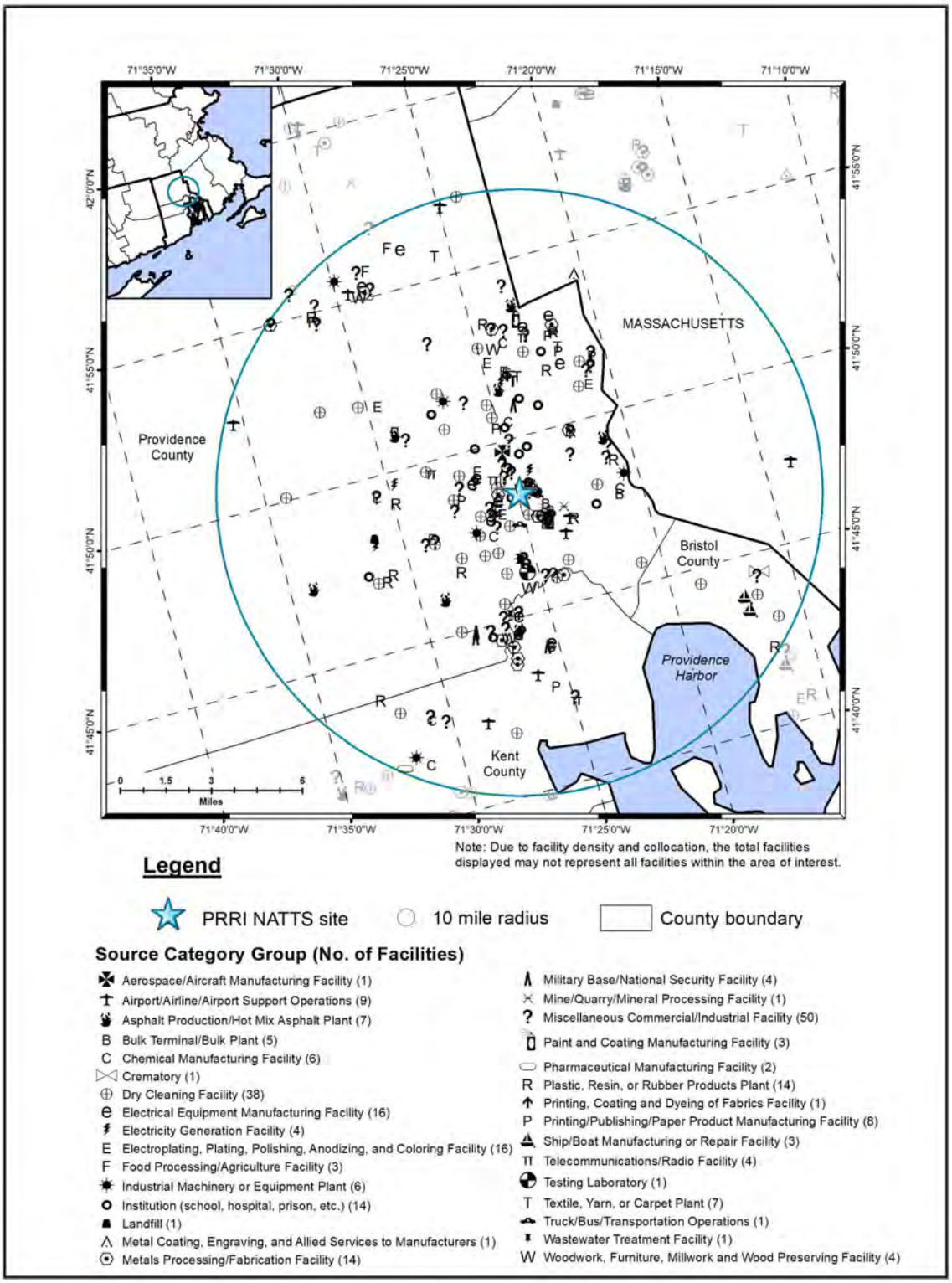


Table 19-1. Geographical Information for the Rhode Island Monitoring Site

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Annual Average Daily Traffic[1]	Intersection Used for Traffic Data
PRRI	44-007-0022	Providence	Providence	Providence-Warwick, RI-MA	41.807776, -71.415105	Residential	Urban/City Center	148,000	I-95 near I-195

[1] AADT reflects 2015 data (RI DOT, 2016)

BOLD ITALICS = EPA-designated NATTS Site

Figure 19-1 shows that the areas to the west and south of PRRI are primarily residential, but areas to the north and east are commercial. A hospital lies to the northeast of the site, just north of Dudley Street. Interstate-95 runs north-south about one-half mile to the east of the site, then turns northwestward, skirting around downtown Providence. Industrial areas are located between Providence Harbor and I-95, as shown on the right-hand side of Figure 19-1.

Figure 19-2 shows that a large number of point sources are located within 10 miles of PRRI, most of which are within about 5 miles of the site. The source categories with the greatest number of point sources within 10 miles of PRRI include dry cleaners; electroplating, plating, polishing, anodizing, and coloring facilities; electrical equipment manufacturing facilities; plastic, resin, or rubber products facilities; institutions (such as schools, prisons, and hospitals); and metals processing and fabrication facilities. Sources within one-half mile of PRRI include several hospitals, a heliport at a hospital, and a facility that falls into the miscellaneous commercial and industrial source category.

In addition to providing city, county, CBSA, and land use/location setting information, Table 19-1 also contains traffic volume information for the site as well as the location for which the traffic volume was obtained. This information is provided because emissions from motor vehicles can significantly affect concentrations measured at a given monitoring site. The traffic volume experienced near PRRI is nearly 150,000 and is the seventh highest compared to traffic volumes near other NMP monitoring sites. The traffic estimate provided is for I-95 near the I-195 interchange.

19.2 Pollutants of Interest

The risk-based screening process described in Section 3.2 was performed for each site to identify site-specific "pollutants of interest," which allows analysts and readers to focus on a subset of pollutants through the context of risk. Each pollutant's preprocessed daily measurement was compared to its associated risk screening value. If the concentration was greater than the risk screening value, then the concentration "failed the screen." The site-specific results of this risk-based screening process are presented in Table 19-2 and incorporate measurements from both 2015 and 2016. Pollutants of interest are those for which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens and are shaded in gray in Table 19-2. It is important to note which pollutants were sampled for at each site when reviewing the results of this analysis. PAHs were sampled for at PRRI under the NMP in 2015 and 2016.

Table 19-2. 2015-2016 Risk-Based Screening Results for the Rhode Island Monitoring Site

Pollutant	Screening Value (µg/m^3)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Providence, Rhode Island - PRRI						
Naphthalene	0.029	99	120	82.50	94.29	94.29
Fluorene	0.011	3	81	3.70	2.86	97.14
Benzo(a)pyrene	0.00057	2	118	1.69	1.90	99.05
Acenaphthene	0.011	1	91	1.10	0.95	100.00
Total		105	410	25.61		

Observations from Table 19-2 include the following:

- Concentrations of four PAHs failed at least one screen for PRRI; nearly 26 percent of concentrations for these four pollutants were greater than their associated risk screening value (or failed screens).
- Concentrations of naphthalene account for 99 of the 105 total failed screens.
- Naphthalene and fluorene together contribute to 95 percent of failed screens for PRRI and therefore were identified as pollutants of interest for this site.

For each of the data analyses described in the remaining sections, the focus is on the site-specific pollutants of interest identified via the risk-based screening process, as described in Section 3.4.2.

19.3 Concentrations

This section presents various concentration averages used to characterize air toxics concentration levels at the Rhode Island monitoring site. Where applicable, the following calculations and data analyses were performed for each of the site-specific pollutants of interest:

- Time period-based concentration averages (quarterly and annual) are provided for each monitoring site for each year of sampling.
- The range of measurements and annual concentration averages are presented graphically to illustrate how each site's concentrations compare to the program-level averages, as presented in Section 4.1.
- Concentration averages and other statistical metrics for 2015, 2016, and from previous years of monitoring are presented in order to characterize concentration trends at each site.

Each data analysis is performed where the applicable criteria are met (as specified in the appropriate sections discussed below) and is limited to the site-specific pollutants of interest. However, site-specific statistical summaries for all pollutants sampled for at PRRI are provided in Appendix N.

19.3.1 2015 and 2016 Concentration Averages

Quarterly and annual concentration averages for 2015 and 2016 were calculated for the pollutants of interest for the Rhode Island site, as described in Section 3.1. The *quarterly average concentration* of a particular pollutant is simply the average concentration of the preprocessed daily measurements over a given calendar quarter. Quarterly average concentrations include the substitution of zeros for all non-detects. A site must have a minimum of 75 percent valid samples compared to the total number of samples possible within a given calendar quarter for a quarterly average to be calculated. An *annual average concentration* includes all measured detections and substituted zeros for non-detects for an entire year of sampling. Annual averages were calculated for pollutants where three valid quarterly averages could be calculated for a given year and where method completeness was greater than or equal to 85 percent, as presented in Section 2.4. Quarterly and annual average concentrations for the pollutants of interest for PRRI are presented in Table 19-3, where applicable. Note that if a pollutant was not detected in a given calendar quarter, the quarterly average simply reflects “0” because only zeros substituted for non-detects were factored into the quarterly average concentration.

Table 19-3. Quarterly and Annual Average Concentrations of the Pollutants of Interest for the Rhode Island Monitoring Site

Pollutant	2015						2016					
	# of Detects/ # >MDL/ # Samples	Q1 Avg (ng/m^3)	Q2 Avg (ng/m^3)	Q3 Avg (ng/m^3)	Q4 Avg (ng/m^3)	Annual Average (ng/m^3)	# of Detects/ # >MDL/ # Samples	Q1 Avg (ng/m^3)	Q2 Avg (ng/m^3)	Q3 Avg (ng/m^3)	Q4 Avg (ng/m^3)	Annual Average (ng/m^3)
Providence, Rhode Island - PRRI												
Fluorene	41/41/60	1.78 ± 0.38	2.71 ± 0.83	4.50 ± 1.05	0.48 ± 0.53	2.24 ± 0.51	40/40/60	0	2.61 ± 1.20	6.76 ± 2.26	3.47 ± 1.06	3.17 ± 0.90
Naphthalene	60/60/60	59.77 ± 11.60	38.04 ± 7.04	49.98 ± 11.49	60.48 ± 21.46	52.63 ± 7.62	60/60/60	50.81 ± 23.16	44.21 ± 11.81	55.05 ± 12.77	70.35 ± 19.62	55.21 ± 8.76

Observations for PRRI from Table 19-3 include the following:

- Naphthalene was detected in all of the valid PAH samples collected at PRRI.

- Concentrations of naphthalene measured at PRRI vary in magnitude, ranging from 7.70 ng/m^3 to 203 ng/m^3. For both years, the second quarter has the lowest quarterly average concentration and the fourth quarter has the highest, although the confidence intervals are relatively large, indicating considerable variability in the measurements. The annual average concentration of naphthalene for 2015 is fairly similar to the annual average for 2016.

- Fluorene was detected in nearly 70 percent of the PAH samples collected each year. The "0" shown for the first quarter average concentration for 2016 indicates that this pollutant was not detected during this calendar quarter. There were no measured detections of fluorene for a four-month period between December 8, 2015 and April 12, 2016. Eighteen of the 20 non-detects measured in 2016 were from this period.

- Concentrations of fluorene measured at PRRI range from 1.19 ng/m^3 to 16.1 ng/m^3, plus the non-detects. Measurements collected in 2016 are more variable than those collected in 2015, based on the confidence intervals shown. The confidence interval for the fourth quarter of 2015 is larger than the average itself (0.48 ± 0.53 ng/m^3); there were only three measured detections during this quarter, and 15 non-detects.

19.3.2 Concentration Comparison

In order to better illustrate how each site's annual average concentrations compare to the program-level averages, a site-specific box plot was created for each of the site-specific pollutants of interest, where applicable. Thus, box plots were created for each of the pollutants listed in Table 19-3 for PRRI. Figures 19-3 and 19-4 overlay PRRI's minimum, annual average, and maximum concentrations for each year onto the program-level minimum, first quartile, median, average, third quartile, and maximum concentrations, as described in Section 3.4.2.1, and are discussed below. If an annual average concentration could not be calculated, the range of concentrations are still provided in the figures that follow.

Figure 19-3. Program vs. Site-Specific Average Fluorene Concentrations

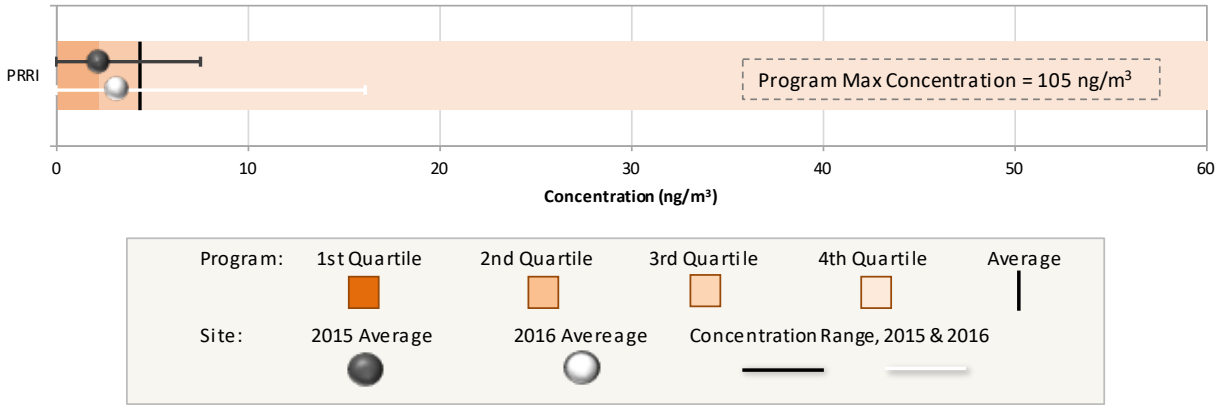


Figure 19-3 presents the box plot for fluorene for PRRI and shows the following:

- The program-level maximum fluorene concentration (105 ng/m^3) is not shown directly on the box plot in Figure 19-3 as the scale of the box plot has been reduced to allow for the observation of data points at the lower end of the concentration range. Note that the first quartile is zero and therefore not visible on the box plot due to the number of non-detects.

- The range of fluorene concentrations measured at fluorene in 2016 is more than twice the range of concentrations measured in 2015. Five fluorene concentrations measured in 2016 are higher than the maximum concentration measured in 2015. The number of fluorene concentrations greater than 5 ng/m^3 measured in 2016 (12) is more than twice the number measured in 2015 (5).

- PRRI's annual average fluorene concentration for 2015 is similar to the program-level median concentration of 2.25 ng/m^3. PRRI's annual average for 2016 is slightly higher, falling between the program-level median and average (4.36 ng/m^3) concentrations.

Figure 19-4. Program vs. Site-Specific Average Naphthalene Concentrations

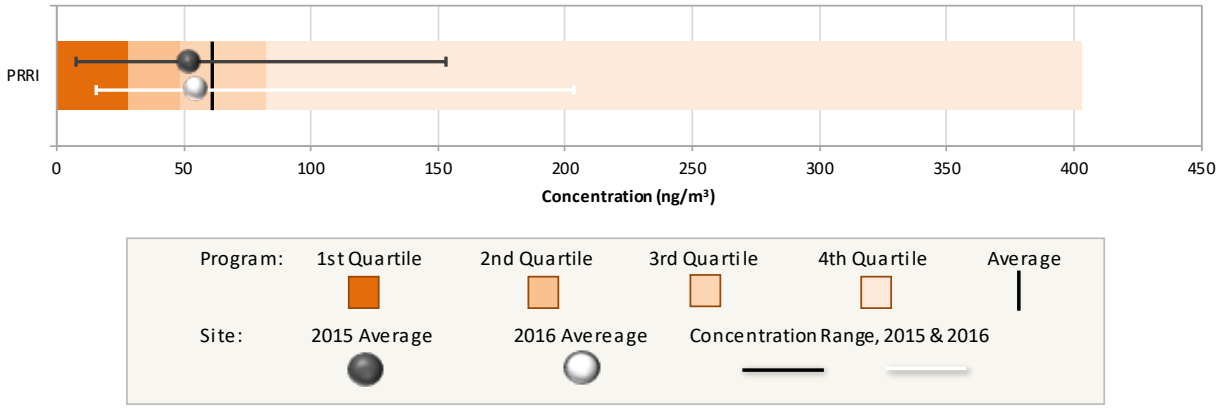


Figure 19-4 presents the box plot for naphthalene for PRRI and shows the following:

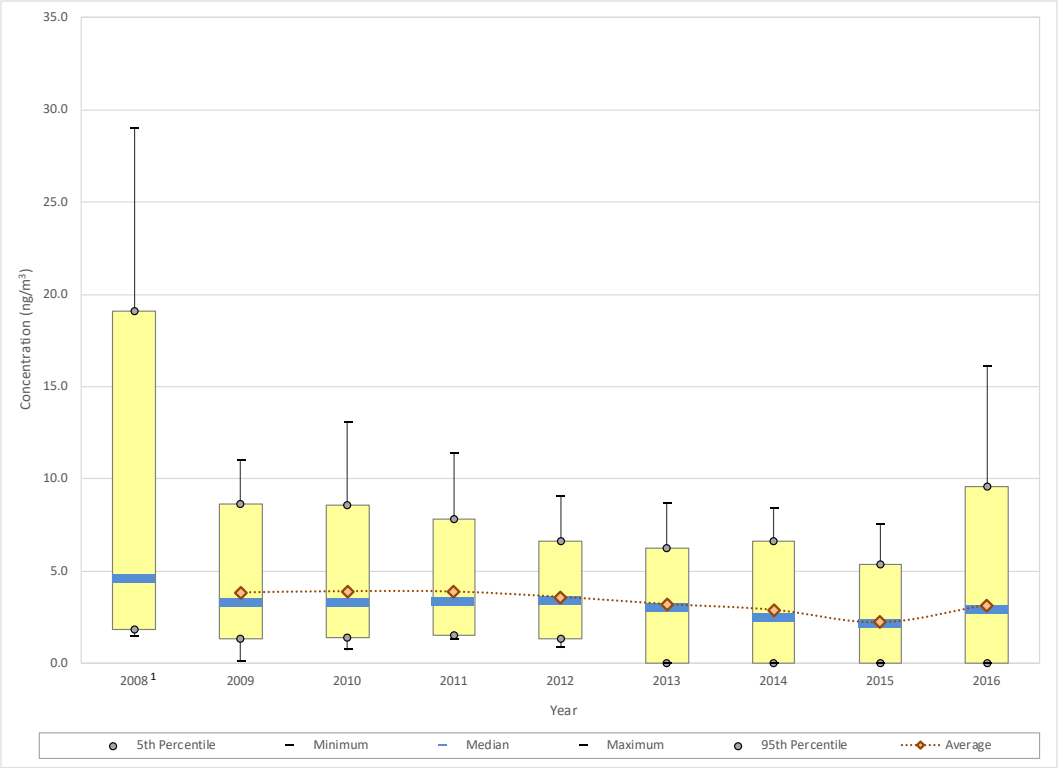
- The maximum naphthalene concentration measured at PRRI was measured in 2016 and is half the magnitude of the maximum concentration measured across the program.

- Both annual average concentrations for PRRI fall between the program-level median (48.90 ng/m^3) and average concentrations (61.23 ng/m^3). PRRI's annual average concentrations of naphthalene are in the lower half of the range compared to other NMP sites sampling PAHs (ranking 21st and 23rd).

19.3.3 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the pollutants of interest for 5 consecutive years or longer, as described in Section 3.4.2.2. PAHs have been sampled at PRRI under the NMP since 2008. Thus, Figures 19-5 and 19-6 presents the 1-year statistical metrics for the pollutants of interest for PRRI. The statistical metrics presented for assessing trends include the substitution of zeros for non-detects. If sampling began mid-year, a minimum of 6 months of sampling is required for inclusion in the trends analysis; in these cases, a 1-year average concentration is not provided, although the range and percentiles are still presented.

Figure 19-5. Yearly Statistical Metrics for Fluorene Concentrations Measured at PRRI



[1] A 1-year average is not presented because sampling under the NMP did not begin until July 2008.

Observations from Figure 19-5 for fluorene concentrations measured at PRRI include the following:

- PRRI began sampling PAHs under the NMP in July 2008. Because a full year's worth of data is not available, a 1-year average concentration is not presented for 2008, although the range of measurements is provided.

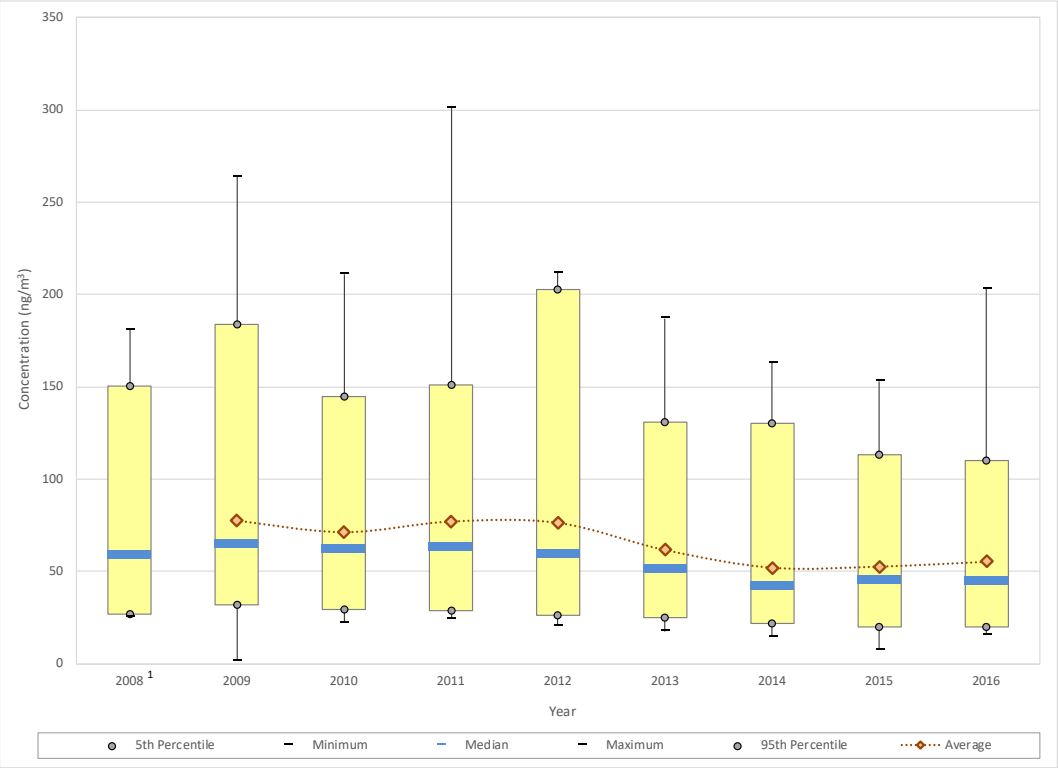
- The only two fluorene concentrations greater than 20 ng/m^3 were both measured in August 2008 (29 ng/m^3 and 22 ng/m^3). This is also the only year that a concentration less than 1 ng/m^3 was not measured. Note, however, that 2008 includes half a year's worth of data.

- The concentration range decreases considerably for 2009. The concentration profile changes only slightly between 2009 and 2010.

- After 2010, fluorene concentrations measured at PRRI have a decreasing trend, with most of the statistical parameters at a minimum for 2015.

- With the exception of the minimum and 5th percentile (which did not change), each of the statistical parameters exhibits an increase for 2016. The maximum concentration (16.1 ng/m^3) and 95th percentile are both at their highest since 2008.

Figure 19-6. Yearly Statistical Metrics for Naphthalene Concentrations Measured at PRRI



[1] A 1-year average is not presented because sampling under the NMP did not begin until July 2008.

Observations from Figure 19-6 for naphthalene concentrations measured at PRRI include the following:

- The maximum naphthalene concentration was measured at PRRI in 2011 (301 ng/m^3). In total, 11 naphthalene concentrations greater than 200 ng/m^3 have been measured at PRRI, of which seven were measured in November of any given year. Of the 27 naphthalene concentrations greater than 150 ng/m^3 measured at PRRI, more than half (18) were measured during the fourth quarter of any given year and 24 of these 27 were measured during the first or fourth quarters (or the colder months of the year).

- Although the range of concentrations measured has varied between 2009 and 2012, the 1-year average concentrations of naphthalene exhibit little variability, ranging from 71.39 ng/m^3 (2010) to 77.73 ng/m^3 (2009). This is also true for the median concentration, which, including 2008, ranges from 58.90 ng/m^3 (2008) to 64.80 ng/m^3 (2009).

- The concentrations of naphthalene measured at PRRI have a decreasing trend between 2012 and 2014. The 1-year average and median concentrations are both at a minimum for 2014; the median concentration is less than 50 ng/m^3 for the first time since the onset of sampling.

- For 2015, some statistical parameters, such as the maximum and minimum concentrations and the 5th percentile, exhibit additional decreases, while the central tendency parameters exhibit slight increases, although the median concentration remains less than 50 ng/m^3. Relatively little change is shown in the concentration profile for 2016, although the maximum concentration measured is greater than 200 ng/m^3 for the first time in several years.

19.4 Additional Risk-Based Screening Evaluations

The following risk-based screening evaluations were conducted to characterize risk related to the air toxics measured at the PRRI monitoring site. Refer to Sections 3.2, 3.4.2.3, and 3.4.2.4 for definitions and explanations regarding the various toxicity factors, time frames, and calculations associated with these risk-based screenings.

19.4.1 Cancer Risk and Noncancer Hazard Approximations

For the pollutants of interest for the Rhode Island monitoring site, risk was examined by calculating cancer risk and noncancer hazard approximations for each year annual average concentrations could be calculated. These approximations can be used as risk estimates for cancer and noncancer effects attributable to the pollutants of interest. Although the use of these approximations is limited, they may help identify where policy-makers want to shift their air monitoring priorities. Refer to Section 3.4.2.3 for an explanation of how cancer risk and noncancer hazard approximations are calculated and what limitations are associated with them. Annual averages, cancer UREs and/or noncancer RfCs, and cancer risk and noncancer hazard approximations are presented in Table 19-4, where applicable. Cancer risk approximations are presented as probabilities while the noncancer hazard approximations are ratios and thus, unitless values.

Observations for PRRI from Table 19-4 include the following:

- Naphthalene has both a cancer URE and a noncancer RfC while only a cancer RfC is available for fluorene.

- The cancer risk approximations for naphthalene are both less than 2 in-a-million. The cancer risk approximations for fluorene are an order of magnitude less.

- The noncancer hazard approximations for naphthalene are negligible (both 0.02), indicating that no adverse noncancer health effects are expected from this individual pollutant.

Table 19-4. Risk Approximations for the Rhode Island Monitoring Site

Pollutant	Cancer URE ($\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	2015				2016			
			# of Measured Detections vs. # of Samples	Annual Average (ng/m^3)	Risk Approximations		# of Measured Detections vs. # of Samples	Annual Average (ng/m^3)	Risk Approximations	
					Cancer (in-a-million)	Noncancer (HQ)			Cancer (in-a-million)	Noncancer (HQ)
Providence, Rhode Island - PRRI										
Fluorene	0.000088	--	41/60	2.24 ± 0.51	0.20	--	40/60	3.17 ± 0.90	0.28	--
Naphthalene	0.000034	0.003	60/60	52.63 ± 7.62	1.79	0.02	60/60	55.21 ± 8.76	1.88	0.02

-- = A Cancer URE or Noncancer RfC is not available.

19.4.2 Risk-Based Emissions Assessment

In addition to the risk-based screening discussed above, this section presents an evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 19-5 presents the 10 pollutants with the highest emissions from the 2014 NEI (version 1) that have cancer toxicity factors. Table 19-5 also presents the 10 pollutants with the highest toxicity-weighted emissions, based on the weighting schema described in Section 3.4.2.4. Lastly, Table 19-5 provides the pollutants of interest with the highest cancer risk approximations (in-a-million) for PRRI, as presented in Table 19-4. Cancer risk approximations for 2015 are presented in green while approximations for 2016 are in white. The emissions, toxicity-weighted emissions, and cancer risk approximations are shown in descending order in Table 19-5. Table 19-6 presents similar information, but is limited to those pollutants with noncancer toxicity factors.

Because not all pollutants have both cancer and noncancer toxicity factors, the highest emitted pollutants in the cancer table may be different from the noncancer table, although the actual quantity of emissions is the same. The cancer risk and noncancer hazard approximations based on the site's annual averages are limited to the pollutants of interest identified for each site. In addition, the cancer risk and noncancer hazard approximations are limited to those pollutants with enough data to meet the criteria for annual averages to be calculated. A more in-depth discussion of this analysis is provided in Section 3.4.2.4. Similar to the cancer risk and noncancer hazard approximations provided in Section 19.4.1, this analysis may help policy-makers prioritize their air monitoring activities.

Table 19-5. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Rhode Island Monitoring Site

Top 10 Total Emissions for Pollutants with Cancer UREs (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Providence, Rhode Island (Providence County) - PRRI					
Benzene	174.63	Formaldehyde	2.16E-03	Naphthalene	1.88
Formaldehyde	166.18	Benzene	1.36E-03	Naphthalene	1.79
Acetaldehyde	93.86	1,3-Butadiene	8.05E-04	Fluorene	0.28
Ethylbenzene	82.84	Naphthalene	7.47E-04	Fluorene	0.20
1,3-Butadiene	26.83	POM, Group 2b	3.22E-04		
Bis(2-ethylhexyl) phthalate, gas	23.54	Arsenic, PM	3.14E-04		
Naphthalene	21.96	POM, Group 2d	2.55E-04		
Tetrachloroethylene	15.82	POM, Group 5a	2.40E-04		
Trichloroethylene	8.17	Ethylbenzene	2.07E-04		
POM, Group 2b	3.66	Acetaldehyde	2.06E-04		

[1] Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Table 19-6. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the Rhode Island Monitoring Site

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific) [1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Hazard Approximation (HQ)**
Providence, Rhode Island (Providence County) - PRRI					
Toluene	585.59	Acrolein	509,316.97	Naphthalene	0.02
Methanol	312.84	2,4-Toluene diisocyanate	28,964.64	Naphthalene	0.02
Xylenes	309.37	Formaldehyde	16,956.90		
Benzene	174.63	1,3-Butadiene	13,412.76		
Formaldehyde	166.18	Acetaldehyde	10,428.55		
Hexane	99.45	Naphthalene	7,321.59		
Acetaldehyde	93.86	Benzene	5,820.86		
Ethylbenzene	82.84	Cadmium, PM	5,291.88		
Ethylene glycol	34.11	Arsenic, PM	4,864.13		
1,3-Butadiene	26.83	Trichloroethylene	4,085.59		

[1] Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Observations from Table 19-5 include the following:

- Benzene, formaldehyde, and acetaldehyde are the highest emitted pollutants with cancer UREs in Providence County.

- Formaldehyde is the pollutant with the highest toxicity-weighted emissions (of the pollutants with cancer UREs), followed by benzene and 1,3-butadiene.

- Seven of the highest emitted pollutants also have the highest toxicity-weighted emissions for Providence County.

- Naphthalene has the seventh highest emissions and the fourth highest toxicity-weighted emissions for Providence County. Fluorene is part of POM, Group 2b, which has the tenth highest emissions and the fifth highest toxicity-weighted emissions for Providence County.

- Additional POM Groups appear among the pollutants with the highest toxicity-weighted emissions for Providence County. POM, Groups 2d and 5a rank seventh and eighth, respectively, for their toxicity-weighted emissions. POM, Group 5a includes benzo(a)pyrene, which failed a single screen for PRRI; POM, Group 2d does not include any of the PAHs sampled for at PRRI.

Observations from Table 19-6 include the following:

- Toluene, methanol, and xylenes are the highest emitted pollutants with noncancer RfCs in Providence County.

- The pollutants with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) are acrolein, 2,4-toluene diisocyanate, and formaldehyde.

- Four of the highest emitted pollutants in Providence County also have the highest toxicity-weighted emissions.

- Although naphthalene ranks sixth among the pollutants with the highest toxicity-weighted emissions, it is not one of the highest emitted pollutants (with a noncancer RfC) in Providence County (it ranks 12th). None of the POM Groups appear in either emissions-based list in Table 19-6.

19.5 Summary of the 2015-2016 Monitoring Data for PRRI

Results from several of the data analyses described in this section include the following:

- ❖ *Concentrations of four PAHs failed screens for PRRI. Naphthalene and fluorene were identified as pollutants of interest for PRRI, with concentrations of naphthalene accounting for the majority of failed screens.*

- ❖ *Concentrations of naphthalene measured at PRRI do not vary significantly across the two years of sampling. The range of fluorene concentrations measured at PRRI in 2016 is twice the range measured in 2015.*

- *Concentrations of naphthalene measured at PRRI have a decreasing trend that has leveled out over the last two years. Fluorene concentrations also exhibited a decreasing trend that lasted several years, before increasing for 2016.*

20.0 Site in Utah

This section summarizes those data from samples collected at the NATTS site in Utah and generated by ERG, EPA's contract laboratory for the NMP, over the 2015 and 2016 monitoring efforts. This section also examines the spatial and temporal characteristics of the ambient monitoring concentrations and reviews them through the context of risk. Readers are encouraged to refer to Sections 1 through 4 for detailed discussions and definitions regarding the various data analyses presented below.

Data generated by sources other than ERG, EPA's contract laboratory for the NMP, are not included in the data analyses contained in this report.

20.1 Site Characterization

This section characterizes the Utah monitoring site by providing a description of the nearby area surrounding the monitoring site; plotting emissions sources surrounding the monitoring site; and presenting traffic data and other characterizing information for the site. This information is provided to give the reader insight regarding factors that may influence the air quality near the site and assist in the interpretation of the ambient monitoring measurements.

The BTUT monitoring site is located in Bountiful, in northern Utah. Figure 20-1 presents a composite satellite image retrieved from ArcGIS Explorer showing the monitoring site and its immediate surroundings. Figure 20-2 identifies nearby point source emissions locations by source category, as reported in the 2014 NEI for point sources, version 1. Note that only sources within 10 miles of the site are included in the facility counts provided in Figure 20-2. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have a direct effect on the air quality at the monitoring site. Further, this boundary provides both the proximity of emissions sources to the monitoring site as well as the quantity of such sources within a given distance of the site. Sources outside the 10-mile boundary are still visible on the map for reference but have been grayed out to emphasize emissions sources within the boundary. Table 20-1 provides supplemental geographical information such as land use, location setting, and locational coordinates. Each figure and table is discussed in detail in the paragraphs that follow.

Figure 20-1. Bountiful, Utah (BTUT) Monitoring Site

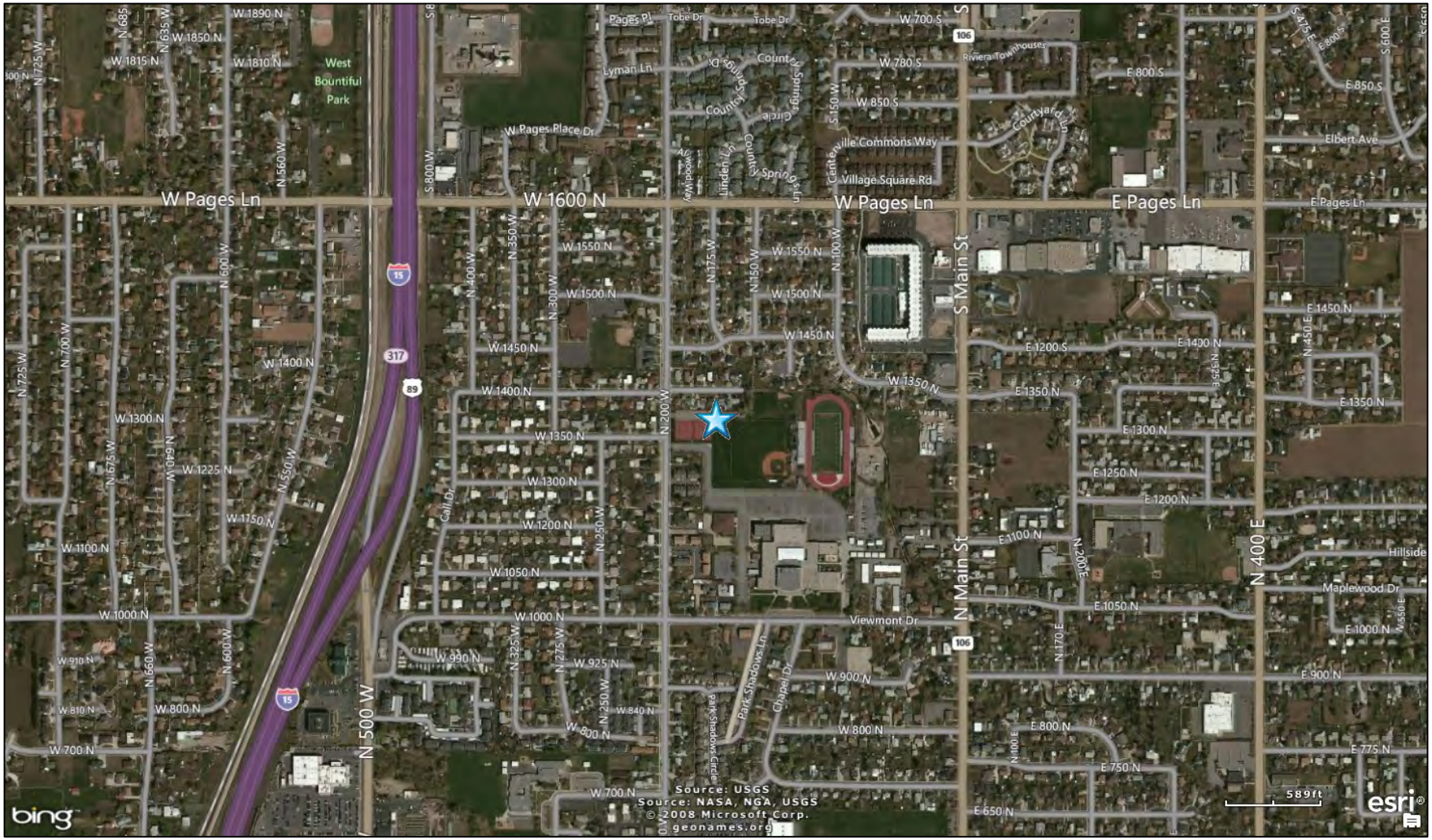


Figure 20-2. NEI Point Sources Located Within 10 Miles of BTUT

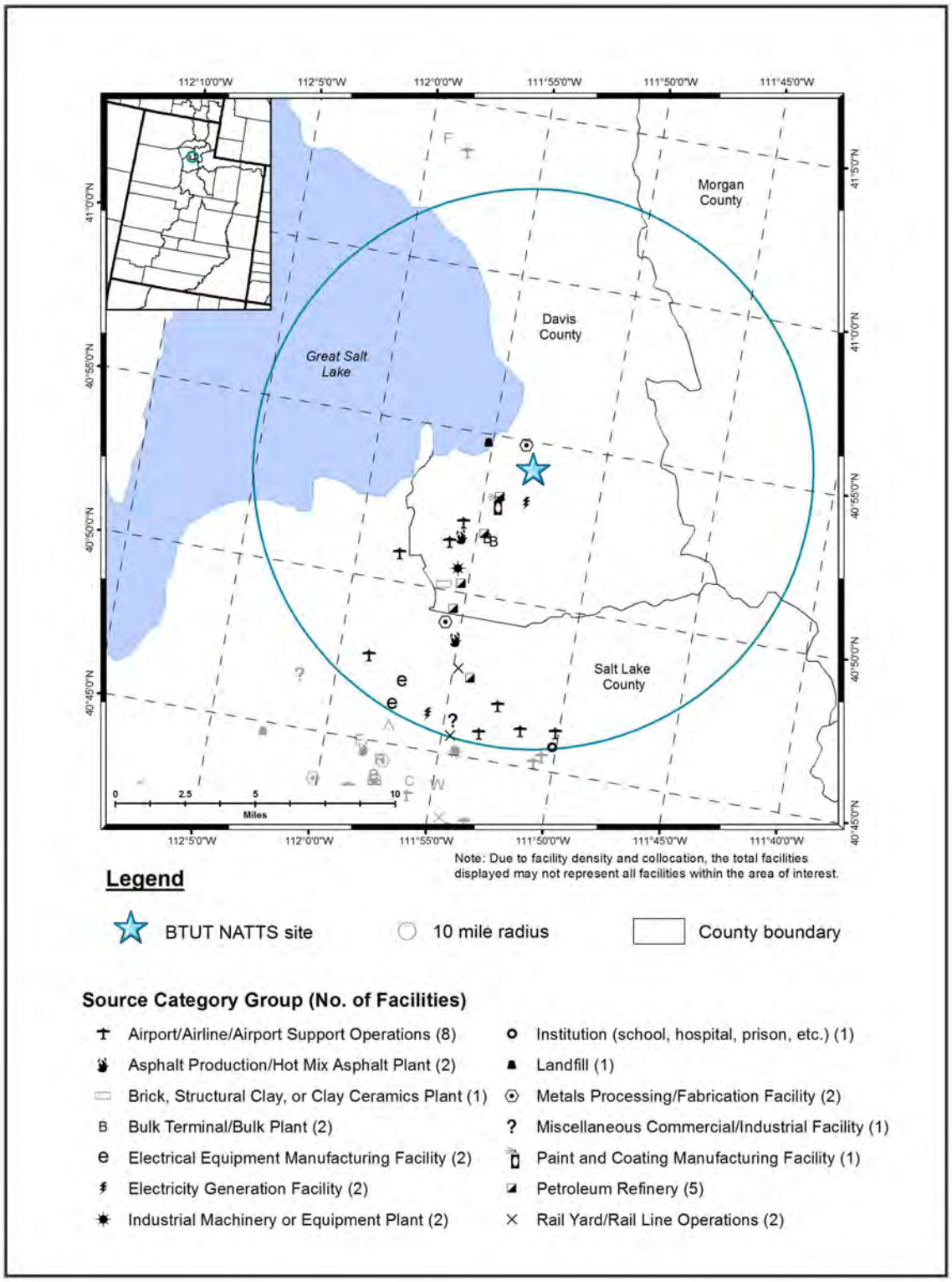


Table 20-1. Geographical Information for the Utah Monitoring Site

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Annual Average Daily Traffic[1]	Intersection Used for Traffic Data
BTUT	49-011-0004	Bountiful	Davis	Ogden-Clearfield, UT	40.902967, -111.884467	Residential	Suburban	133,965	I-15, north of Hwy 89 junction

[1]AADT reflects 2014 data (UT DOT, 2014)

BOLD ITALICS = EPA-designated NATTS Site

Bountiful is north of Salt Lake City and is situated in a valley between the Great Salt Lake to the west and the Wasatch Mountains to the east. Figure 20-1 shows that BTUT is located on the property of Viewmont High School, in a primarily residential area. The site is located about one-third of a mile from I-15, which runs north-south through most of the surrounding urban area including Salt Lake City, Clearfield, and Ogden.

Figure 20-2 shows that most of the point sources near BTUT are located to the south of the site and run parallel to I-15. The facilities near BTUT are involved in a variety of industries, although the source categories with the greatest number of point sources surrounding BTUT are the airport and airport support operations category and the petroleum refinery source category. The airport source category includes airports and related operations as well as small runways and heliports, such as those associated with hospitals or television stations. Point sources within 2 miles of BTUT include a metals processing/fabrication facility, a facility generating electricity via combustion, a petroleum refinery, a paint and coatings manufacturer, and a landfill.

In addition to providing city, county, CBSA, and land use/location setting information, Table 20-1 also contains traffic volume information for the site as well as the location for which the traffic volume was obtained. This information is provided because emissions from motor vehicles can significantly affect concentrations measured at a given monitoring site. The traffic volume experienced near BTUT is nearly 134,000 and is among the higher traffic volumes compared to those for other NMP sites. The traffic estimate provided is for I-15, north of the Highway 89 junction, just west of the site.

20.2 Pollutants of Interest

The risk-based screening process described in Section 3.2 was performed for each site to identify site-specific "pollutants of interest," which allows analysts and readers to focus on a subset of pollutants through the context of risk. Each pollutant's preprocessed daily measurement was compared to its associated risk screening value. If the concentration was greater than the risk screening value, then the concentration "failed the screen." The site-specific results of this risk-based screening process are presented in Table 20-2 and incorporate measurements from both 2015 and 2016. Pollutants of interest are those for which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens and are shaded in gray in Table 20-2. It is important to note which pollutants were sampled for at each site when reviewing the results of this analysis. VOCs, carbonyl compounds, SNMOCs, PAHs, and metals (PM_{10})

were sampled for at BTUT. BTUT is one of only two NMP sites sampling both SNMOC and VOCs (NBIL is the other).

Table 20-2. 2015-2016 Risk-Based Screening Results for the Utah Monitoring Site

Pollutant	Screening Value ($\mu g/m^3$)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Bountiful, Utah - BTUT						
Acetaldehyde	0.45	113	113	100.00	12.38	12.38
Formaldehyde	0.077	113	113	100.00	12.38	24.75
Benzene	0.13	109	109	100.00	11.94	36.69
Carbon Tetrachloride	0.17	107	109	98.17	11.72	48.41
1,2-Dichloroethane	0.038	100	100	100.00	10.95	59.36
Arsenic (PM_{10})	0.00023	95	113	84.07	10.41	69.77
1,3-Butadiene	0.03	95	105	90.48	10.41	80.18
Naphthalene	0.029	91	117	77.78	9.97	90.14
Hexachloro-1,3-butadiene	0.045	17	17	100.00	1.86	92.00
Nickel (PM_{10})	0.0021	15	115	13.04	1.64	93.65
Propionaldehyde	0.8	15	113	13.27	1.64	95.29
Ethylbenzene	0.4	12	109	11.01	1.31	96.60
Dichloromethane	60	7	109	6.42	0.77	97.37
p-Dichlorobenzene	0.091	5	29	17.24	0.55	97.92
Fluorene	0.011	5	64	7.81	0.55	98.47
Acenaphthene	0.011	4	94	4.26	0.44	98.90
Cadmium (PM_{10})	0.00056	4	115	3.48	0.44	99.34
1,2-Dibromoethane	0.0017	2	2	100.00	0.22	99.56
Benzo(a)pyrene	0.00057	1	57	1.75	0.11	99.67
Lead (PM_{10})	0.015	1	115	0.87	0.11	99.78
Manganese (PM_{10})	0.03	1	115	0.87	0.11	99.89
1,1,2-Trichloroethane	0.0625	1	1	100.00	0.11	100.00
Total		913	1,934	47.21		

Observations from Table 20-2 include the following:

- Concentrations of 22 pollutants failed at least one screen for BTUT; approximately 47 percent of concentrations for these 22 pollutants were greater than their associated risk screening value (or failed screens). BTUT has the second highest number of individual pollutants failing screens.

- Concentrations of 11 pollutants contributed to 95 percent of failed screens for BTUT and therefore were identified as pollutants of interest for this site. These 11 include three carbonyl compounds, five VOCs, two PM_{10} metals, and one PAH.

- BTUT is one of only two NMP sites for which propionaldehyde is a pollutant of interest (BROK is the other).

- Acetaldehyde, formaldehyde, and benzene were detected in every valid carbonyl compound and VOC sample collected at BTUT and failed 100 percent of screens. Other pollutants also failed 100 percent of screens but were detected less frequently.

- As described in Section 3.2, if a pollutant was measured by both the TO-15 and SNMOC methods at the same site, the TO-15 results were used for the risk-based screening process. As BTUT sampled both VOCs (TO-15) and SNMOCs, the TO-15 results were used for the 12 pollutants these methods have in common.

20.3 Concentrations

This section presents various concentration averages used to characterize air toxics concentration levels at the Utah monitoring site. Where applicable, the following calculations and data analyses were performed for each of the site-specific pollutants of interest:

- Time period-based concentration averages (quarterly and annual) are provided for each monitoring site for each year of sampling.

- The range of measurements and annual concentration averages are presented graphically for each site to illustrate how the site's concentrations compare to the program-level averages, as presented in Section 4.1.

- Concentration averages and other statistical metrics for 2015, 2016, and from previous years of monitoring are presented in order to characterize concentration trends at each site.

Each data analysis is performed where the applicable criteria are met (as specified in the appropriate sections discussed below) and is limited to the site-specific pollutants of interest. However, site-specific statistical summaries for all pollutants sampled for at BTUT are provided in Appendices J, K, M, N, and O.

20.3.1 2015 and 2016 Concentration Averages

Quarterly and annual concentration averages for 2015 and 2016 were calculated for the pollutants of interest for BTUT, as described in Section 3.1. The *quarterly average concentration* of a particular pollutant is simply the average concentration of the preprocessed daily measurements over a given calendar quarter. Quarterly average concentrations include the substitution of zeros for all non-detects. A site must have a minimum of 75 percent valid samples compared to the total number of samples possible within a given calendar quarter for a quarterly average to be calculated. An *annual average concentration* includes all measured detections and substituted zeros for non-detects for an entire year of sampling. Annual averages were calculated for pollutants where three valid quarterly averages could be calculated for a given year and where method completeness was greater than or equal to 85 percent, as presented in Section 2.4. Quarterly and annual average concentrations for the Utah monitoring site are presented in Table 20-3, where applicable. Note that concentrations of the PAHs and PM_{10} metals are presented in ng/m^3 in Table 20-3 for ease of viewing. Also note that if a pollutant was not detected in a given calendar quarter, the quarterly average concentration simply reflects "0" because only zeros substituted for non-detects were factored into the quarterly average concentration.

Table 20-3. Quarterly and Annual Average Concentrations of the Pollutants of Interest for the Utah Monitoring Site

Pollutant	2015						2016					
	# of Detects/ # >MDL/ # Samples	Q1 Avg (µg/m³)	Q2 Avg (µg/m³)	Q3 Avg (µg/m³)	Q4 Avg (µg/m³)	Annual Average (µg/m³)	# of Detects/ # >MDL/ # Samples	Q1 Avg (µg/m³)	Q2 Avg (µg/m³)	Q3 Avg (µg/m³)	Q4 Avg (µg/m³)	Annual Average (µg/m³)
Bountiful, Utah - BTUT												
Acetaldehyde	54/54/54	3.90 ± 0.86	3.35 ± 0.79	NA	4.42 ± 1.24	3.64 ± 0.48	59/59/59	3.28 ± 0.70	1.59 ± 0.43	2.75 ± 0.46	2.96 ± 0.54	2.62 ± 0.31
Benzene	50/50/50	1.26 ± 0.34	0.53 ± 0.08	0.58 ± 0.18	0.91 ± 0.40	NA	59/59/59	1.03 ± 0.29	0.46 ± 0.10	0.69 ± 0.18	0.72 ± 0.12	0.72 ± 0.10
1,3-Butadiene	47/42/50	0.13 ± 0.06	0.04 ± 0.01	0.03 ± 0.01	0.09 ± 0.04	NA	58/30/59	0.10 ± 0.04	0.05 ± 0.01	0.06 ± 0.02	0.08 ± 0.02	0.07 ± 0.01
Carbon Tetrachloride	50/49/50	0.55 ± 0.11	0.60 ± 0.02	0.64 ± 0.05	0.58 ± 0.03	NA	59/59/59	0.63 ± 0.05	0.68 ± 0.04	0.40 ± 0.11	0.48 ± 0.06	0.56 ± 0.04
1,2-Dichloroethane	47/44/50	0.10 ± 0.02	0.08 ± 0.02	0.05 ± 0.01	0.09 ± 0.01	NA	53/53/59	0.11 ± 0.01	0.10 ± 0.01	0.05 ± 0.02	0.07 ± 0.02	0.08 ± 0.01
Formaldehyde	54/54/54	8.64 ± 1.97	9.43 ± 3.47	NA	9.54 ± 3.09	8.42 ± 1.37	59/59/59	7.34 ± 1.26	3.10 ± 1.19	6.10 ± 1.19	6.42 ± 1.34	5.68 ± 0.72
Hexachloro-1,3-butadiene	3/0/50	NR	NR	NR	NR	NR	14/1/59	0.08 ± 0.14	0.04 ± 0.03	0.02 ± 0.02	0.03 ± 0.02	0.04 ± 0.04
Propionaldehyde	54/54/54	0.70 ± 0.15	0.67 ± 0.16	NA	0.76 ± 0.20	0.67 ± 0.08	59/59/59	0.58 ± 0.11	0.34 ± 0.09	0.57 ± 0.10	0.54 ± 0.09	0.50 ± 0.05
Arsenic (PM_{10})[a]	58/56/60	1.40 ± 0.64	0.45 ± 0.17	0.56 ± 0.12	0.39 ± 0.16	0.70 ± 0.19	55/55/55	0.86 ± 0.72	0.43 ± 0.14	0.54 ± 0.11	1.18 ± 0.57	0.77 ± 0.23
Naphthalene[a]	56/56/56	60.53 ± 20.83	46.01 ± 17.22	45.09 ± 12.29	56.37 ± 16.42	52.25 ± 8.19	61/61/61	44.79 ± 9.93	30.03 ± 7.95	44.45 ± 9.83	46.26 ± 9.35	41.44 ± 4.69
Nickel (PM_{10})[a]	60/59/60	2.05 ± 0.58	1.26 ± 0.27	1.55 ± 0.35	1.25 ± 0.34	1.53 ± 0.21	55/55/55	1.08 ± 0.30	1.08 ± 0.26	1.32 ± 0.32	1.64 ± 0.30	1.30 ± 0.15

[a] Average concentrations provided for the pollutants below the blue line are presented in ng/m³ for ease of viewing.
NA = Not available because the criteria for calculating a quarterly and/or annual average were not met.
NR = Not reportable due to invalidation related to a contaminated internal standard.

Observations for BTUT from Table 20-3 include the following:

- The pollutants of interest with the highest annual average concentrations for both 2015 and 2016 are formaldehyde and acetaldehyde. For both pollutants, the annual average concentrations for 2015 are significantly higher than the annual averages for 2016. This is also true for propionaldehyde, the third carbonyl compound that is a pollutant of interest for BTUT. Each of the available quarterly average concentrations of these pollutants for 2015 are greater than the quarterly average concentrations for 2016.

- A review of the formaldehyde data shows that concentrations measured at BTUT range from 0.843 µg/m^3 to 25.5 µg/m^3, with the nine highest formaldehyde concentrations measured in 2015. All but two of the 19 formaldehyde concentrations greater than 10 µg/m^3 measured at BTUT were measured in 2015, including the two highest concentrations measured across the program. Similarly, 20 of the 25 highest acetaldehyde concentrations (those greater than 4 µg/m^3) were measured at BTUT in 2015. The five propionaldehyde concentrations greater than 1 µg/m^3 measured at BTUT were also measured in 2015.

- A number of invalid canister samples scattered throughout the year resulted in a VOC completeness less than 85 percent for BTUT in 2015. As a result, annual average concentrations could not be calculated for 2015. For 2016, the VOCs with the highest annual average concentrations are benzene and carbon tetrachloride; the annual averages for the remaining VOCs are all less than 0.1 µg/m^3.

- For both years, the first quarter average concentration of benzene is greater than 1 µg/m^3. Nine of the 12 benzene concentrations greater than 1 µg/m^3 measured at BTUT in 2015 were measured during the first quarter of the year (with none measured during the second quarter, one during the third, and two during the fourth). Similarly, seven of the 11 benzene concentrations greater than 1 µg/m^3 measured at BTUT in 2016 were measured during the first quarter of the year (with none measured during the second quarter, two during the third, and two during the fourth).

- The third and fourth quarter average concentrations of carbon tetrachloride for 2016 are the lowest quarterly average concentrations of this pollutant among all NMP sites sampling VOCs. BTUT has the highest number of carbon tetrachloride measurements less than 0.4 µg/m^3 among all NMP sites (15), 13 of which were measured during the second half of 2016. The other two were both measured during the first quarter of 2015, including the minimum concentration of carbon tetrachloride measured across the program (0.0378 µg/m^3).

- Quarterly and annual averages for hexachloro-1,3-butadiene for 2015 are not presented in Table 20-3 due to the use of a contaminated internal standard at the laboratory for Method TO-15, which resulted in the invalidation of the results from early March 2015 through mid-December 2015, as described in Section 2.4. For 2016, the first quarterly average concentration for 2016 (0.08 ± 0.14 µg/m^3) is twice the next highest quarterly average and has an associated confidence interval greater than the average itself. The maximum concentration of this pollutant among NMP sites sampling VOCs was measured at BTUT (1.02 µg/m^3, with all other

measurements program-wide 0.15 µg/m^3 or less). Concentrations of hexachloro-1,3-butadiene measured at BTUT in 2016 range from 0.0748 µg/m^3 to 1.02 µg/m^3, with 45 non-detects.

- The first quarter average concentration of arsenic for 2015 is two to three times higher than the other quarterly average concentrations for that year. Six of the seven arsenic concentrations greater than 1 ng/m^3 that were measured in 2015 were measured in January or February. The first quarter also has the fewest arsenic concentrations (3) less than 0.5 ng/m^3 among the quarterly average concentrations for 2015 (with between six and nine measured during each of the remaining calendar quarters). For 2016, the nine arsenic concentrations greater than 1 ng/m^3 were measured at BTUT during the first and fourth quarters of the year, including two measurements greater than 4 ng/m^3.

- The first quarter average concentration of nickel for 2015 (2.05 ± 0.58 ng/m^3) is the highest of the quarterly average concentrations for BTUT, both for 2015 and 2016. Of the 11 nickel concentrations greater than 2 ng/m^3 measured at BTUT in 2015, seven were measured during the first quarter, while the remaining four were measured in August. The six nickel concentrations greater than 2 ng/m^3 measured at BTUT in 2016 were measured between the end of September and the end of the year. This is reflected in the quarterly average concentrations of nickel for 2016.

- Of the 15 naphthalene concentrations greater than 75 ng/m^3 measured at BTUT, 11 were measured in 2015, including all five concentrations greater than 100 ng/m^3. The annual average concentration of naphthalene for 2015 is higher than the annual average for 2016, though the difference is not statistically significant. Note that the confidence intervals calculated for the quarterly and annual average concentrations for 2015 are larger than each of those calculated for 2016, indicating that naphthalene measurements collected in 2015 exhibit more variability.

Tables 4-10 through 4-13 present the NMP sites with the 10 highest annual average concentrations for each of the program-level pollutants of interest. Observations for BTUT from those tables include the following:

- BTUT has the highest annual average concentration for hexachloro-1,3-butadiene among NMP sites sampling this pollutant, as shown in Table 4-10. Note that the confidence interval associated with BTUT's 2016 annual average concentration of this pollutant is the same as the annual average itself, indicating the presence of outliers and/or a high-level of variability. The maximum concentration measured at BTUT is an order of magnitude higher than any other measurement of hexachloro-1,3-butadiene measured across the program.

- For the fifth year in a row, BTUT has the highest annual average concentration of formaldehyde among NMP sites sampling carbonyl compounds, as shown in Table 4-11. BTUT's annual averages of formaldehyde rank highest (2015) and third highest (2016), despite the statistically significant difference shown between the two. BTUT's annual average concentrations of acetaldehyde both rank among the five highest annual averages.

- BTUT does not appear in Table 4-12 for PAHs or Table 4-13 for metals.

20.3.2 Concentration Comparison

In order to better illustrate how each site's annual average concentrations compare to the program-level averages, a site-specific box plot was created for each of the site-specific pollutants of interest, where applicable. Thus, box plots were created for the pollutants listed in Table 20-3 for BTUT. Figures 20-3 through 20-13 overlay the site's minimum, annual average, and maximum concentrations for each year onto the program-level minimum, first quartile, median, average, third quartile, and maximum concentrations, as described in Section 3.4.2.1, and are discussed below. If an annual average concentration could not be calculated, the range of concentrations are still provided in the figures that follow.

Figure 20-3. Program vs. Site-Specific Average Acetaldehyde Concentrations

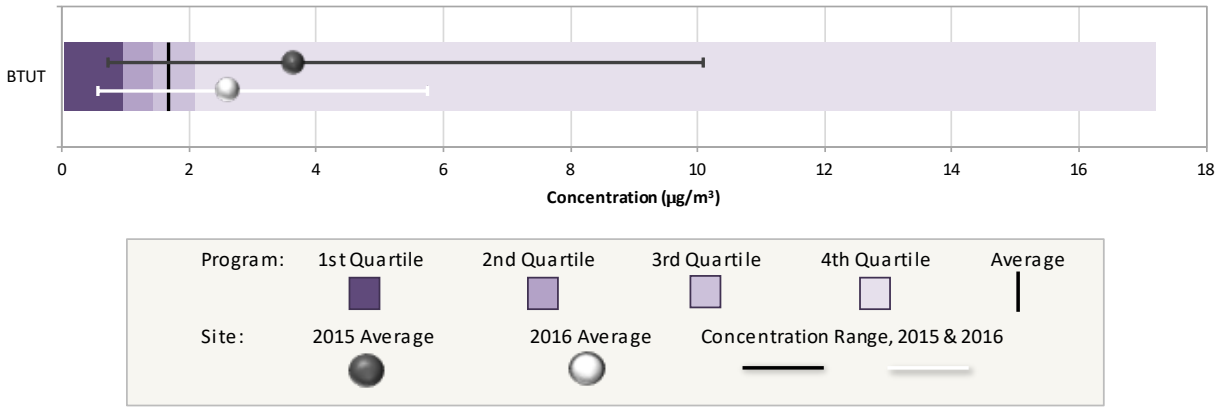


Figure 20-3 presents the box plot for acetaldehyde for BTUT and shows the following:

- The range of acetaldehyde concentrations measured BTUT in 2015 is larger than the range of concentrations measured in 2016.

- Despite the differences in the magnitude of measurements across the two years of sampling, both annual average acetaldehyde concentrations for BTUT are greater than the program-level average concentration (1.67 µg/m^3), as well as the program-level third quartile. The annual average concentrations of acetaldehyde for BTUT are the second (2015) and fifth (2016) highest among NMP sites sampling carbonyl compounds.

Figure 20-4. Program vs. Site-Specific Average Arsenic (PM_{10}) Concentrations

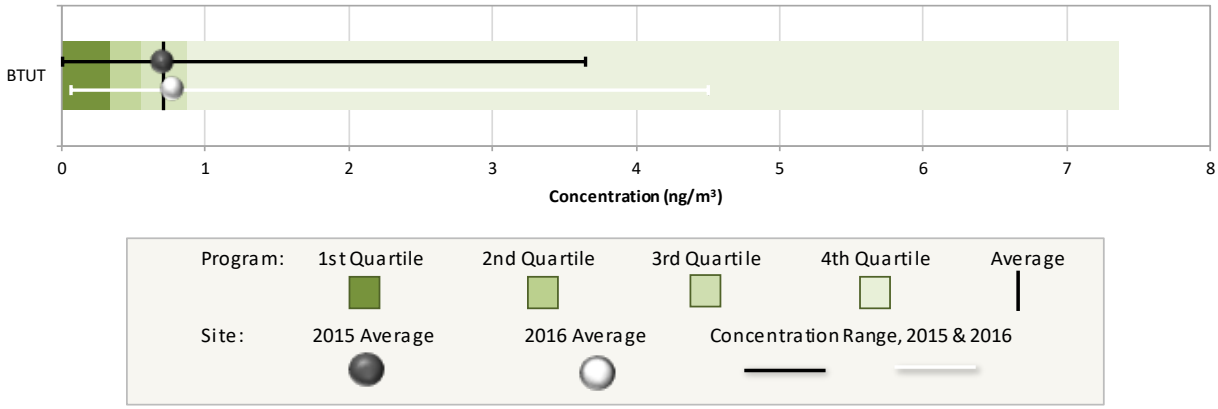


Figure 20-4 presents the box plot for arsenic (PM_{10}) for BTUT and shows the following:

- Although BTUT's maximum arsenic concentration is not the maximum arsenic concentration measured at the program-level, two of the eight arsenic concentrations greater than 4 ng/m^3 measured across the program were measured at BTUT (both in 2016).

- Two of the five non-detects of arsenic measured across the program were measured at BTUT, both in 2015.

- BTUT's annual average concentration of arsenic for 2015 is similar to the program-level average concentration, while the annual average for 2016 is just slightly higher.

Figure 20-5. Program vs. Site-Specific Average Benzene Concentrations

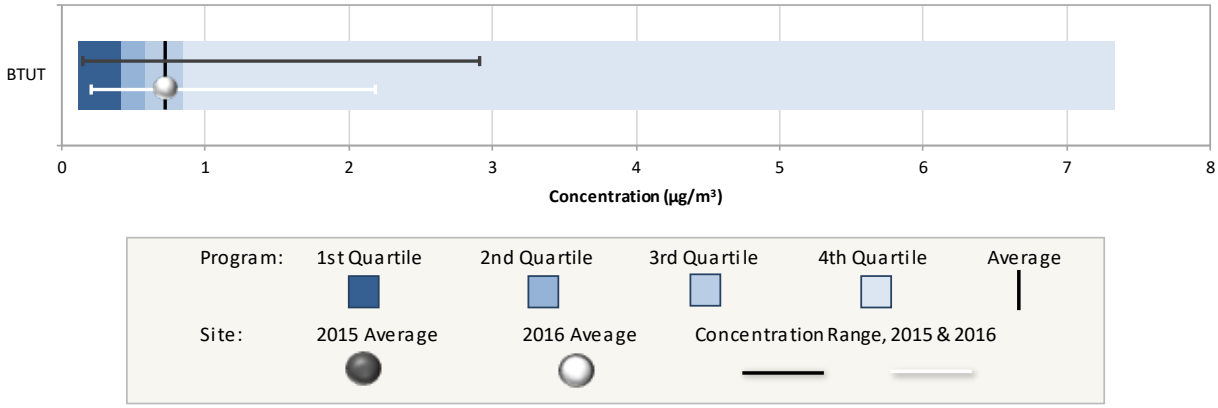


Figure 20-5 presents the box plot for benzene for BTUT and shows the following:

- An annual average concentration for 2015 could not be calculated, although the range of measurements is provided in Figure 20-5.

- Benzene concentrations greater than 3 µg/m^3 were not measured at BTUT in 2015 or 2016.

- The range of benzene concentrations measured BTUT in 2015 is larger than the range of concentrations measured at this site in 2016.

- The minimum benzene concentration measured at BTUT in 2015 (0.144 µg/m^3) is not the minimum concentration measured across the program (0.109 µg/m^3), although it is among the lowest.

- BTUT's annual average concentration of benzene for 2016 is similar to the program-level average concentration (0.72 µg/m^3).

Figure 20-6. Program vs. Site-Specific Average 1,3-Butadiene Concentrations

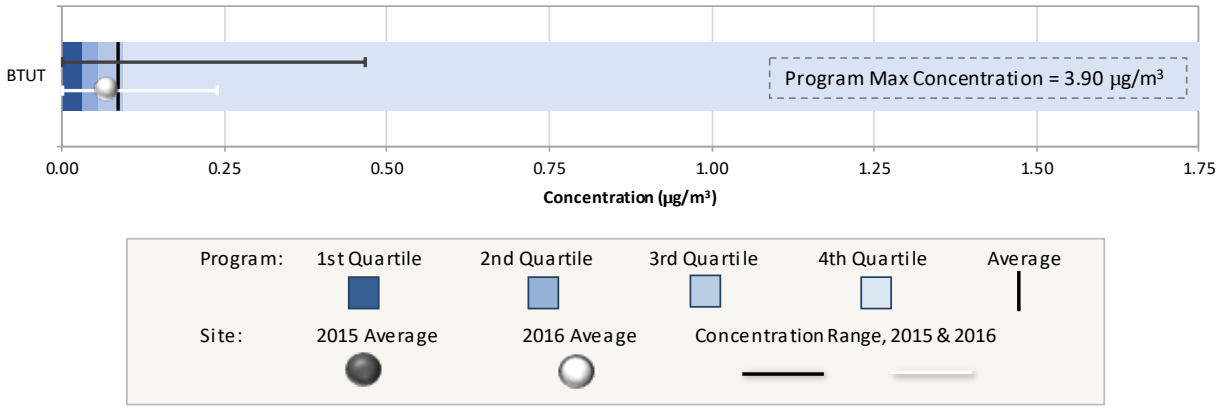


Figure 20-6 presents the box plot for 1,3-butadiene for BTUT and shows the following:

- The program-level maximum 1,3-butadiene concentration (3.90 µg/m^3) is not shown directly on the box plot because the scale of the box plot would be too large to readily observe data points at the lower end of the concentration range. Thus, the scale of the box plot has been reduced.

- An annual average concentration for 2015 could not be calculated, although the range of measurements is provided in Figure 20-6.

- The range of 1,3-butadiene concentrations measured at BTUT in 2015 is twice the range of concentrations measured in 2016. However, if the maximum concentration measured in 2015 was excluded, the range of concentrations measured each year would be similar.

- BTUT's annual average concentration of 1,3-butadiene for 2016 falls between the program-level median (0.06 µg/m^3) and program-level average (0.09 µg/m^3) concentrations.

- Four non-detects were measured at BTUT, three in 2015 and one in 2016.

Figure 20-7. Program vs. Site-Specific Average Carbon Tetrachloride Concentrations

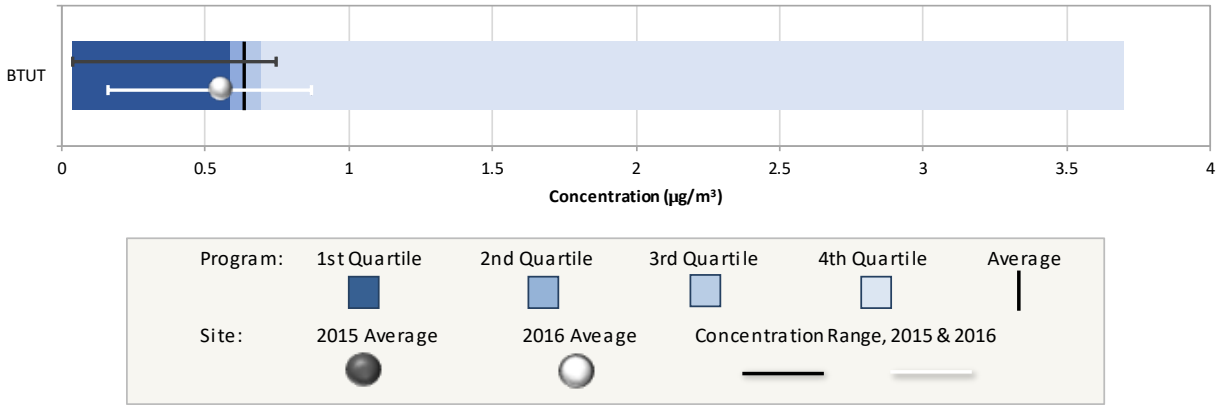


Figure 20-7 presents the box plot for carbon tetrachloride for BTUT and shows the following:

- As with other VOCs, an annual average concentration for 2015 could not be calculated, although the range of measurements is provided in Figure 20-7.
- Carbon tetrachloride concentrations measured at BTUT are all less than 0.9 µg/m^3.
- The minimum carbon tetrachloride concentration measured across the program (0.0378 µg/m^3) was measured at BTUT in 2015. BTUT is the only site for which a concentration less than 0.1 µg/m^3 was measured.
- BTUT's annual average concentration of carbon tetrachloride for 2016 is less than the program-level first quartile and is the lowest annual average concentration among NMP sites sampling this pollutant, although the range of annual averages is relatively small for most of the sites.

Figure 20-8. Program vs. Site-Specific Average 1,2-Dichloroethane Concentrations

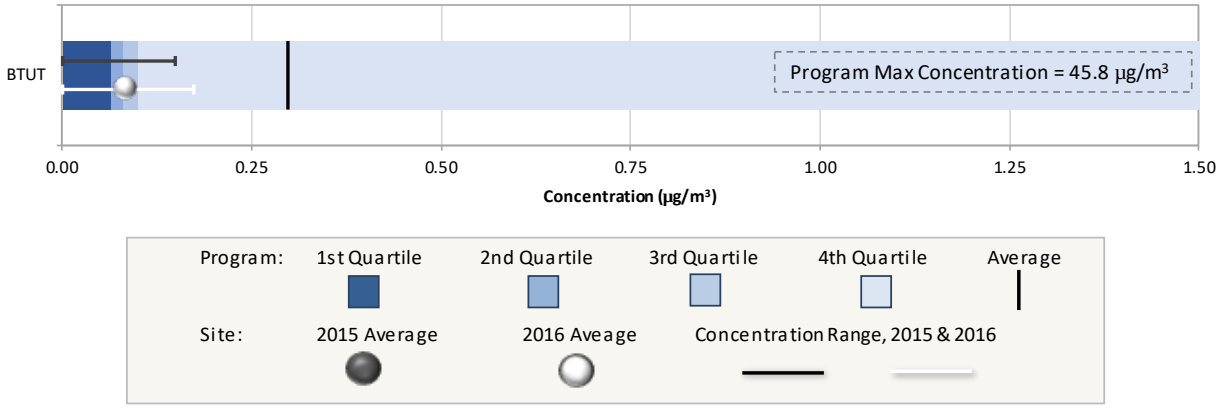


Figure 20-8 presents the box plot for 1,2-dichloroethane for BTUT and shows the following:

- The scale of the box plot in Figure 20-8 has also been reduced to allow for the observation of data points at the lower end of the concentration range, as the program-level maximum 1,2-dichloroethane concentration (45.8 µg/m^3) is considerably greater than the majority of measurements.

- As with other VOCs, an annual average concentration for 2015 could not be calculated, although the range of measurements is provided in Figure 20-8.

- All of the concentrations of 1,2-dichloroethane measured at BTUT are less than the program-level average concentration of 0.30 µg/m^3, which is being driven by the measurements at the upper end of the concentration range.

- BTUT's annual average concentration for 2016 is similar to the program-level median concentration.

- Nine non-detects of 1,2-dichloroethane were measured at BTUT, three in 2015 and six in 2016.

Figure 20-9. Program vs. Site-Specific Average Formaldehyde Concentrations

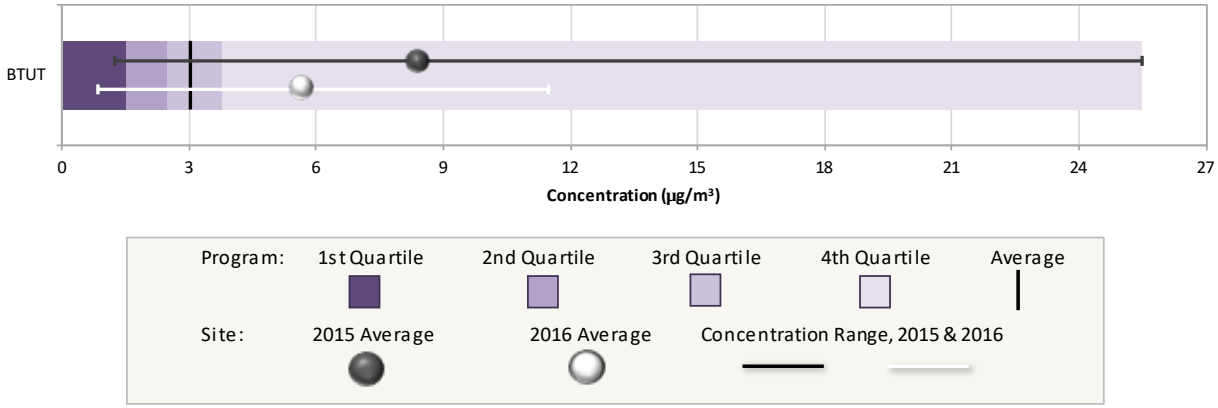


Figure 20-9 presents the box plot for formaldehyde for BTUT and shows the following:

- The two highest formaldehyde concentrations measured at BTUT (25.5 µg/m^3 and 25.4 µg/m^3) are maximum concentrations of formaldehyde measured across the program. These two concentrations were measured in 2015; the maximum concentration measured at BTUT in 2016 is less than half the magnitude of those measured in 2015.

- Both of BTUT's annual average concentrations of formaldehyde are greater than the program-level average concentration (3.05 µg/m^3), even though the annual average for 2016 is one-third less than the annual average for 2015. As discussed in the previous section, BTUT's annual average concentrations of formaldehyde are the highest and third-highest annual averages of formaldehyde among NMP sites sampling carbonyl compounds.

Figure 20-10. Program vs. Site-Specific Average Hexachloro-1,3-butadiene Concentrations

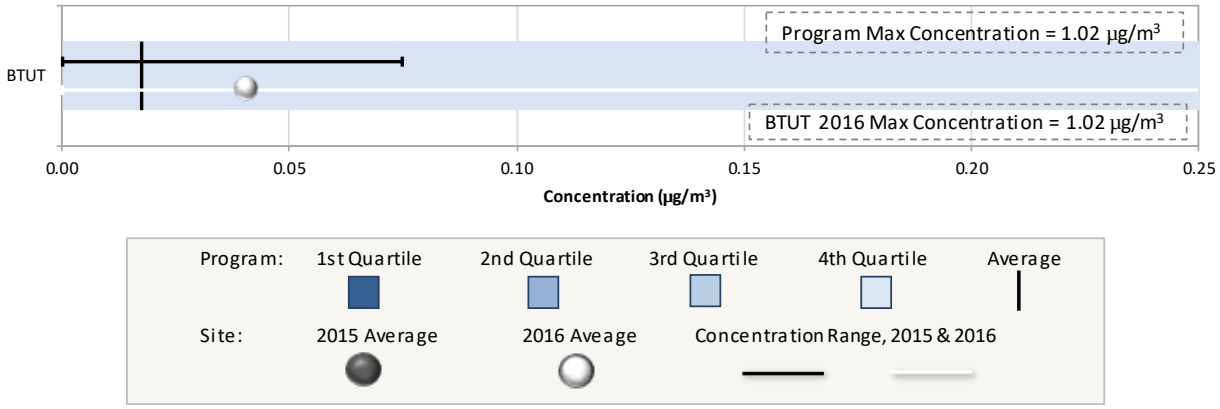


Figure 20-10 presents the box plot for hexachloro-1,3-butadiene for BTUT and shows the following:

- The program-level maximum concentration of hexachloro-1,3-butadiene (1.02 µg/m^3) is not shown directly on the box plot as the scale has been reduced to 0.25 µg/m^3 to allow for the observations data points at the lower end of the concentration range.

- The program-level first, second, and third quartiles are all zero for this pollutant, indicating that at least 75 percent of the measurements across the program are non-detects and thus, are not visible on the box plot.

- Annual average concentrations for hexachloro-1,3-butadiene were not calculated for 2015 due to the use of a contaminated internal standard at the laboratory for Method TO-15, which resulted in the invalidation of the results from early March 2015 through mid-December 2015, as described above and in Section 2.4.

- The maximum concentration of hexachloro-1,3-butadiene measured across the program was measured at BTUT and is the only measurement of this pollutant across the program greater than the MDL. All other concentrations of this pollutant measured at BTUT are 0.15 µg/m^3 or less.

- Fifty-six non-detects of hexachloro-1,3-butadiene were measured at BTUT.

- BTUT's annual average concentration of hexachloro-1,3-butadiene for 2016 is nearly two and half times greater than the program-level average concentration (0.017 µg/m^3) and is the highest annual average concentration among NMP sites sampling this pollutant. This is mostly attributable to the maximum concentration measured; if the maximum concentration was excluded from the dataset, BTUT's annual average for 2016 would decrease by almost half, but would still be greater than the program-level average concentration.

Figure 20-11. Program vs. Site-Specific Average Naphthalene Concentrations

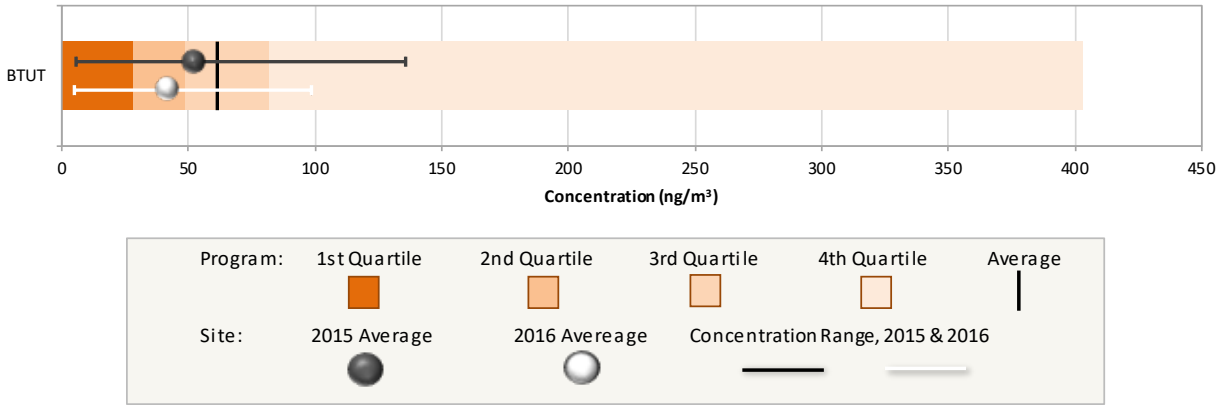


Figure 20-11 presents the box plot for naphthalene for BTUT and shows the following:

- The maximum concentration of naphthalene measured at BTUT (136 ng/m^3) is considerably less than the maximum concentration measured across the program (403 ng/m^3).

- The annual average concentrations of naphthalene for BTUT fall on either side of the program-level median concentration (48.90 ng/m^3).

Figure 20-12. Program vs. Site-Specific Average Nickel (PM_{10}) Concentrations

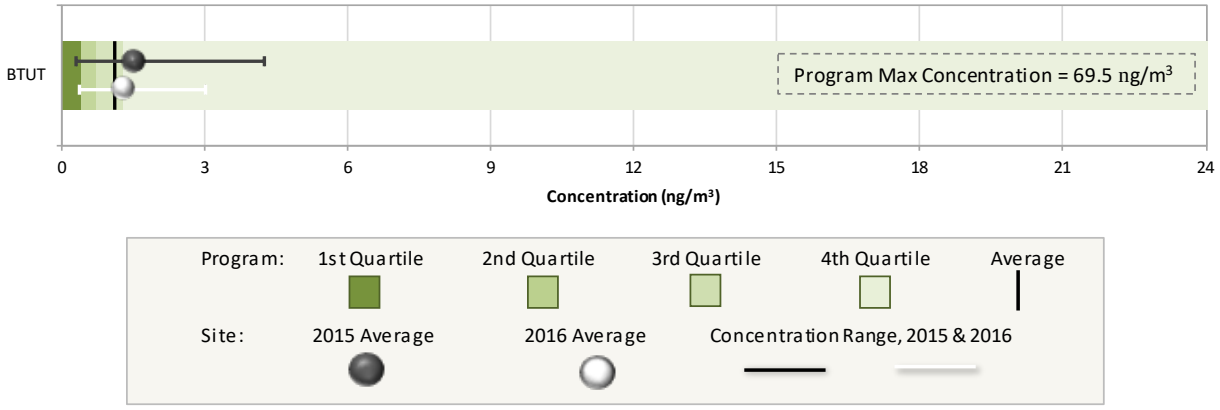


Figure 20-12 presents the box plot for nickel (PM_{10}) for BTUT and shows the following:

- The program-level maximum concentration of nickel (69.5 ng/m^3) is not shown directly on the box plot as the scale has also been reduced to allow for the observations data points at the lower end of the concentration range.

- The three highest nickel concentrations measured at BTUT were measured in 2015.

- Both annual average concentrations of nickel for BTUT are greater than the program-level average concentration (1.09 ng/m^3); the annual average for 2015 is also greater than the program-level third quartile (1.30 ng/m^3) while the annual average for 2016 is similar to the third quartile.

Figure 20-13. Program vs. Site-Specific Average Propionaldehyde Concentrations

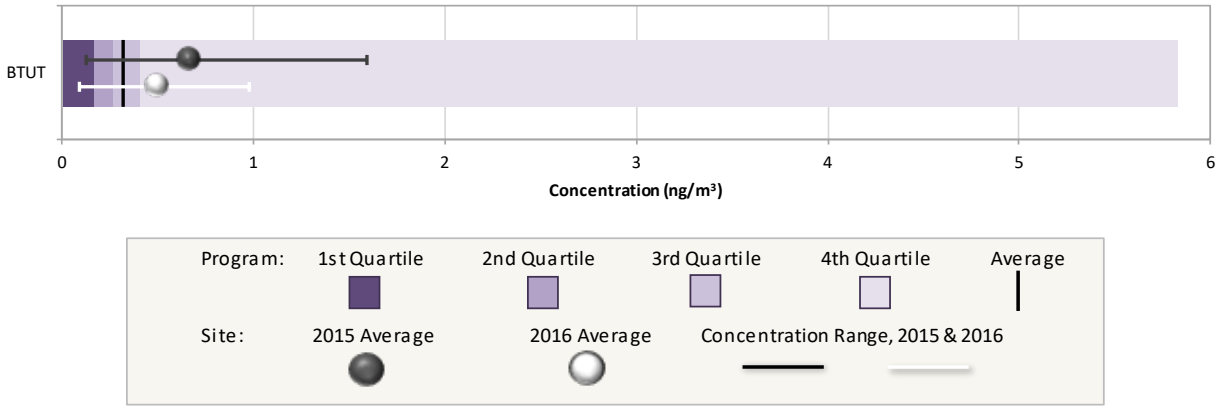


Figure 20-13 presents the box plot for propionaldehyde for BTUT and shows the following:

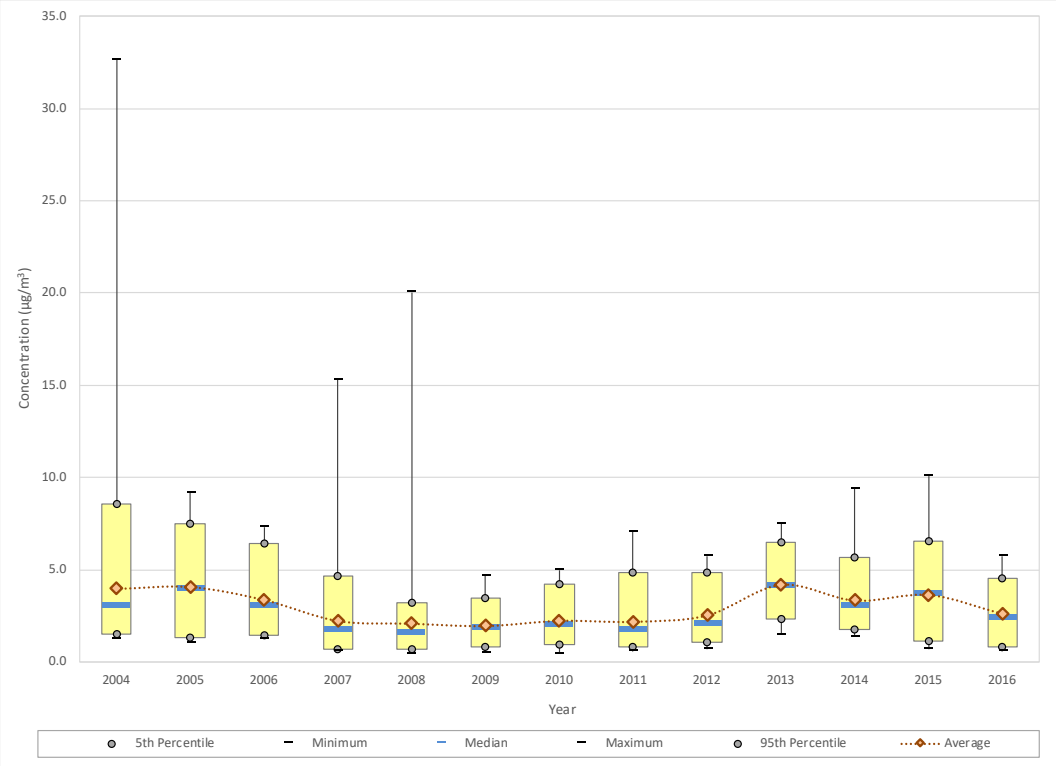
- Although the maximum concentration of propionaldehyde was not measured at BTUT, concentrations greater than the maximum concentration measured at BTUT were measured at only two NMP sites (BROK, where the maximum concentration was measured, and SPIL).

- Both annual average concentrations of propionaldehyde for BTUT are greater than the program-level average concentration (0.32 µg/m^3) and the third quartile, with BTUT's annual average for 2015 more than twice the program-level average.

20.3.3 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the pollutants of interest for 5 consecutive years or longer, as described in Section 3.4.2.2. BTUT has sampled carbonyl compounds, VOCs, metals, and SNMOCs under the NMP since 2003 and PAHs since 2008. Thus, Figures 20-14 through 20-24 present the 1-year statistical metrics for each of the pollutants of interest for BTUT. The statistical metrics presented for assessing trends include the substitution of zeros for non-detects. If sampling began mid-year, a minimum of 6 months of sampling is required for inclusion in the trends analysis; in these cases, a 1-year average concentration is not provided, although the range and percentiles are still presented.

Figure 20-14. Yearly Statistical Metrics for Acetaldehyde Concentrations Measured at BTUT



Observations from Figure 20-14 for acetaldehyde concentrations measured at BTUT include the following:

- Sampling for carbonyl compounds under the NMP began at BTUT in late July 2003. Because this represents less than half of the sampling year, Figure 20-14 excludes data from 2003.

- The maximum acetaldehyde concentration was measured in 2004 (32.7 µg/m^3). Concentrations of acetaldehyde greater than 10 µg/m^3 were also measured at BTUT in 2008 (20.0 µg/m^3), 2007 (15.3 µg/m^3), another in 2004 (10.8 µg/m^3), and one in 2015 (10.1 µg/m^3).

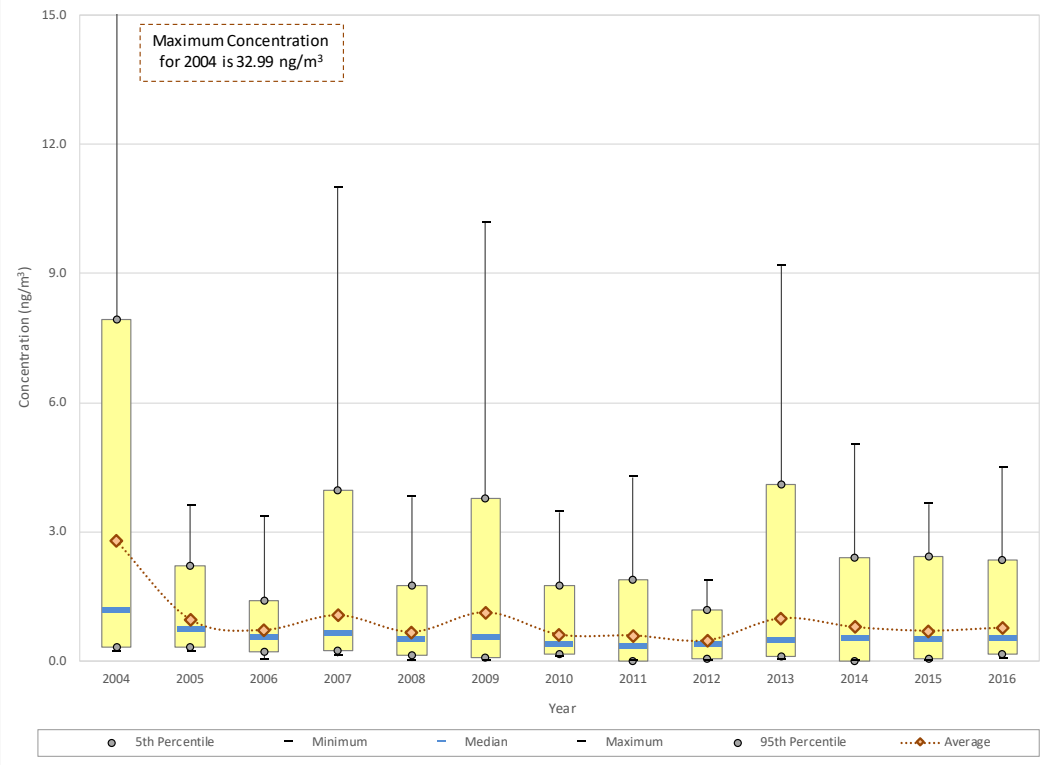
- After 2005, the 1-year average concentration exhibits a steady decreasing trend through 2009, when the 1-year average concentration reaches a minimum (1.97 µg/m^3), although the most significant changes occurred between 2005 and 2007. Between 2007 and 2011, the 1-year average concentration varied by less than 0.3 µg/m^3, ranging from 1.97 µg/m^3 (2009) to 2.25 µg/m^3 (2010).

- Although the range of concentrations measured in 2012 is smaller than the range measured in 2011, a slight increase is shown in both the 1-year average and median concentrations for 2012. The slight increase for 2012 is followed by a significant increase for 2013, with both the 1-year average and median concentrations at a maximum for the period of sampling. The number of acetaldehyde concentrations greater than 4 µg/m^3 increased from seven in 2011 to 11 in 2012 and 32 in 2013.

Additionally, 11 concentrations measured in 2012 are less than the minimum concentration measured in 2013.

- The significant increase shown by the central tendency statistics for 2013 is followed by a significant decrease in these same parameters for 2014. The increases shown for 2015 are followed by significant decreases for 2016, with the 1-year average concentration nearly returning to 2012 levels.

Figure 20-15. Yearly Statistical Metrics for Arsenic (PM_{10}) Concentrations Measured at BTUT



Observations from Figure 20-15 for arsenic concentrations measured at BTUT include the following:

- Sampling for PM_{10} metals under the NMP began at BTUT in late July 2003. Because this represents less than half of the sampling year, Figure 20-15 excludes data from 2003.

- The maximum arsenic concentration was measured at BTUT in 2004 (32.99 ng/m^3) and is nearly twice the next highest concentration (16.84 ng/m^3), also measured in 2004. Eight of the 15 highest concentrations of arsenic (those greater than 5 ng/m^3) were measured at BTUT in 2004.

- Of the 44 arsenic concentrations greater than 3 ng/m^3 measured at BTUT, 40 were measured during the colder months of the year, with 21 measured during the first quarter of the calendar year and 19 measured during the fourth quarter of the calendar year, suggesting a seasonality in the measurements.

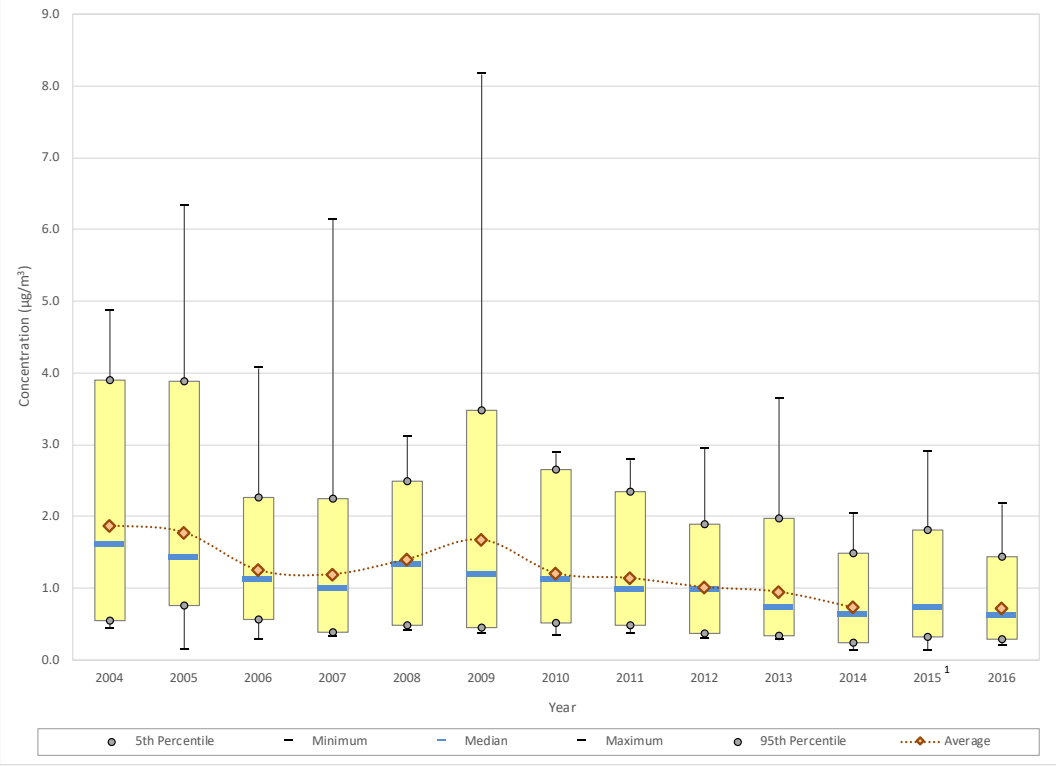
- The average concentration of arsenic decreased significantly from 2004 to 2005, with the 1-year average decreasing from 2.79 ng/m^3 to 0.96 ng/m^3. Between 2006 and 2010, there is an undulating pattern in the 1-year average concentrations, with years with higher concentrations followed by years with lower concentrations. During this period, the 1-year average arsenic concentration fluctuated between 0.61 ng/m^3 (2010) and 1.13 ng/m^3 (2009). However, the 1-year average concentrations for 2007 and 2009 are being driven primarily by a single "high" measurement. If the maximum concentrations measured in 2007 and 2009 were removed from the data sets, the 1-year average concentrations for this period would all be less than 1 ng/m^3.

- Little change in the arsenic concentrations is shown between 2010 and 2011. The smallest range of arsenic concentrations was measured at BTUT in 2012, when all arsenic concentrations measured at BTUT were less than 2 ng/m^3. The 1-year average concentration, along with the 95th percentile and maximum concentration, are at a minimum for 2012.

- Concentrations of arsenic measured at BTUT increased significantly for 2013, as indicated by the increase shown in all of the statistical parameters. Although the 1-year average concentration doubled from 2012 to 2013, the increase in the median concentration is less dramatic.

- With the exception of the median concentration, each of the statistical parameters shown for 2014 exhibits a decrease from the previous year. Little change is shown in most of the statistical parameters after 2014.

Figure 20-16. Yearly Statistical Metrics for Benzene Concentrations Measured at BTUT



[1] A 1-year average is not presented due to low method completeness in 2015.

Observations from Figure 20-16 for benzene concentrations measured at BTUT include the following:

- Sampling for VOCs under the NMP also began at BTUT in late July 2003. Because this represents less than half of the sampling year, Figure 20-16 excludes data from 2003.

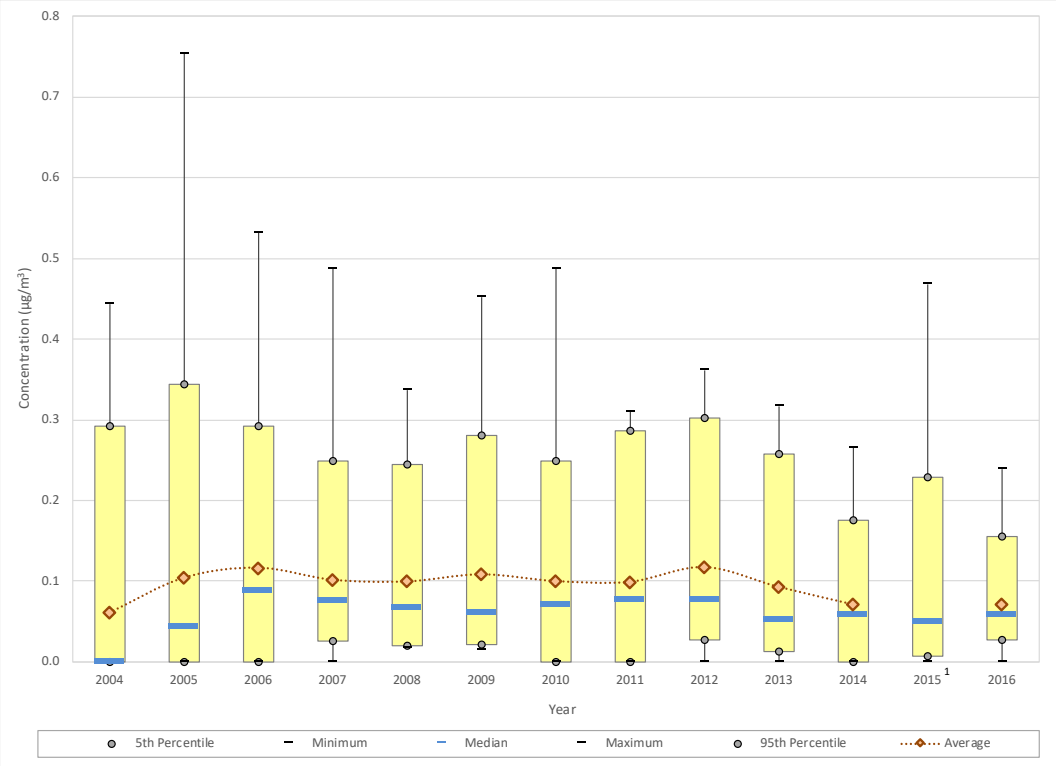
- A 1-year average concentration is not presented for 2015 due to low method completeness, as described in the previous sections.

- The maximum concentration of benzene shown was measured in 2009 (8.16 µg/m^3). The next highest concentration (6.56 µg/m^3) was also measured in 2009, although concentrations greater than 6 µg/m^3 were also measured in 2005 and 2007. Benzene concentrations greater than 4 µg/m^3 have not been measured at BTUT in recent years.

- Concentrations of benzene appear to be higher during the colder months of the year, as 52 of the 56 highest concentrations (those greater than 2.50 µg/m^3) were measured during the first (29) or fourth (23) quarters of the calendar year.

- The 1-year average and median benzene concentrations have a decreasing trend through 2007. An increasing trend in the 1-year average concentration is then shown through 2009, after which another decreasing trend follows. The 1-year average benzene concentration is at a minimum for 2016 (0.72 µg/m^3), although the 1-year average for 2014 is similar. The median concentration is also at a minimum for 2016 (0.62 µg/m^3), though it does not always follow the same pattern as the 1-year average concentration.

Figure 20-17. Yearly Statistical Metrics for 1,3-Butadiene Concentrations Measured at BTUT



[1] A 1-year average is not presented due to low method completeness in 2015.

Observations from Figure 20-17 for 1,3-butadiene concentrations measured at BTUT include the following:

- The maximum concentration of 1,3-butadiene shown was measured in 2005 (0.75 µg/m^3). The second highest concentration was also measured in 2005 (0.53 µg/m^3), although a similar concentration was also measured in 2006. These are the only concentrations of 1,3-butadiene greater than 0.5 µg/m^3 measured at BTUT.

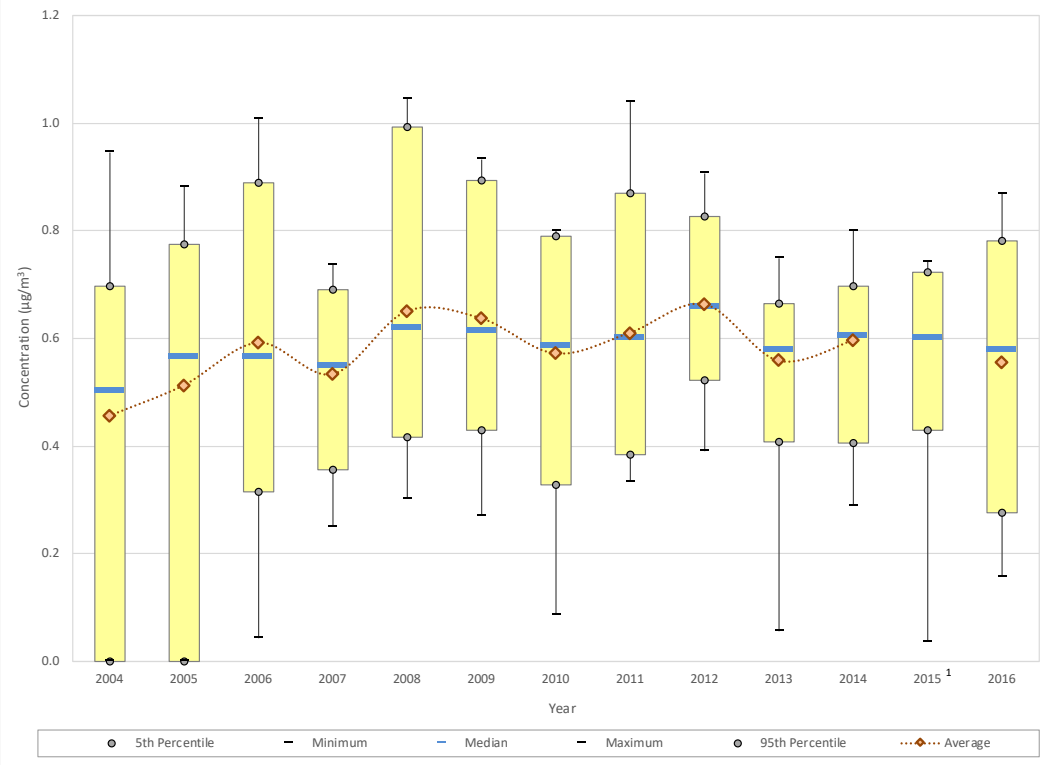
- The minimum, 5th percentile, and median concentrations are all zero for 2004, indicating that at least half of the measurements were non-detects. The detection rate of 1,3-butadiene increased after 2004, as indicated by the increase in the median concentrations for 2005 and 2006, the 5th percentile for 2007, and the minimum concentration for 2008 and 2009. The percentage of non-detects decreased from 75 percent for 2004 to 0 percent for 2008 and 2009. The percentage of non-detects increased to 7 percent for 2010 and 18 percent for 2011, explaining why the 5th percentile returned to zero. Five or fewer non-detects of this pollutant were measured in each year between 2012 and 2016.

- The 1-year average concentration increased from 0.061 µg/m^3 for 2004 to 0.104 µg/m^3 for 2005. This increase is likely due to the decrease in non-detects (and thus zeros substituted for them) as well as the higher concentrations measured in 2005, as discussed above. Between 2005 and 2012, the 1-year average concentration hovers around 0.1 µg/m^3, ranging from 0.099 µg/m^3 (2011) to 0.117 µg/m^3 (2012).

The median concentration varies more, ranging from 0.044 µg/m^3 (2005) to 0.089 µg/m^3 (2006), although the median concentration varies less after these two years.

- A decreasing trend in the 1,3-butadiene concentrations measured at BTUT is shown between 2012 and 2014, the first year that concentrations greater than 0.3 µg/m^3 were not measured. Although a few "higher" concentrations were measured in 2015, the median concentration (0.050 µg/m^3) is at its lowest since 2005. Concentrations greater than 0.3 µg/m^3 were again not measured in 2016, and the 1-year average concentration, the 95th percentile, and the maximum concentration are at a minimum.

Figure 20-18. Yearly Statistical Metrics for Carbon Tetrachloride Concentrations Measured at BTUT



[1] A 1-year average is not presented due to low method completeness in 2015.

Observations from Figure 20-18 for carbon tetrachloride concentrations measured at BTUT include the following:

- Non-detects of carbon tetrachloride were measured only in 2004 (nine) and 2005 (five). Concentrations of carbon tetrachloride greater than 1 µg/m^3 were measured in 2006 (two), 2008 (three), and 2011 (one).

- A significant increasing trend is shown in the 1-year average concentrations between 2004 and 2008, with the exception of 2007. The range and magnitude of concentrations measured decreased substantially for 2007, which is reflected in the dip in the 1-year average concentration. Concentrations greater than 0.8 µg/m^3 were

not measured at BTUT in 2007, although concentrations of this magnitude account for more than 20 percent of measurements for 2006 and 2008.

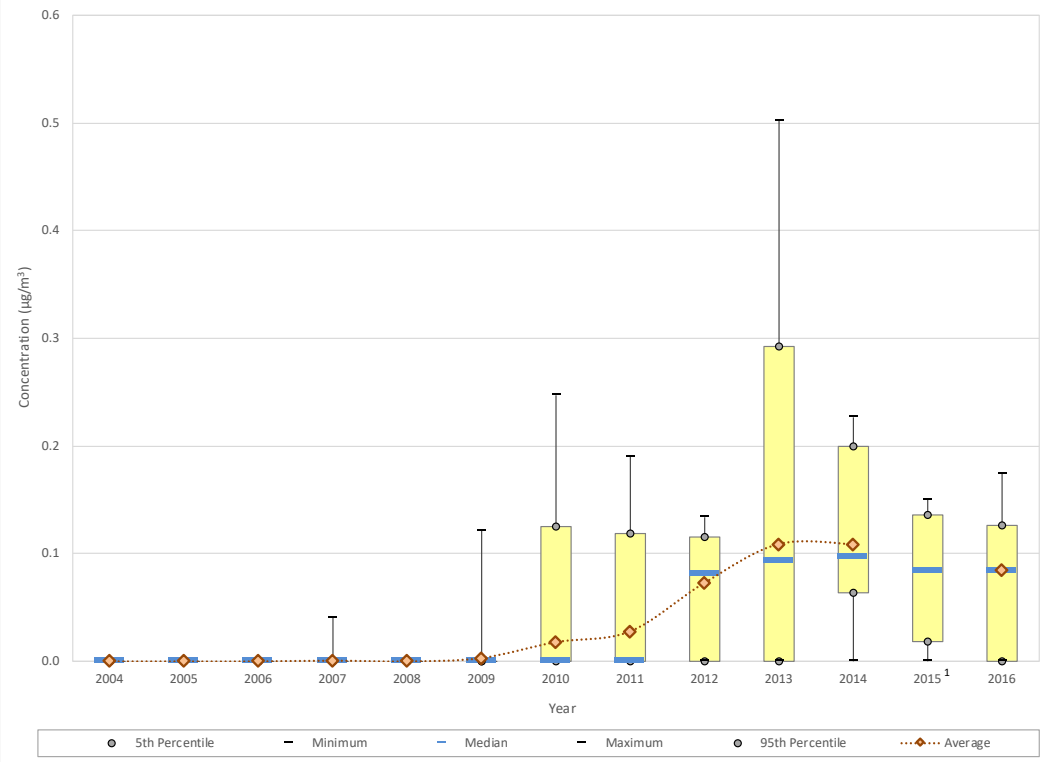
- After decreasing between 2008 and 2010, an increasing trend in the carbon tetrachloride measurements is shown through 2012. Several of the statistical parameters, including the 1-year average and median concentrations, are at a maximum in 2012.

- A significant decrease in the 1-year average concentration, and the other statistical parameters, is shown for 2013. This year has the lowest maximum concentration since 2007 and the lowest minimum concentration since 2006.

- Each of the statistical parameters exhibits at least a slight increase for 2014, with the exception of the 5th percentile, which did not change. The median concentration changed little for 2015, despite variations at the upper and lower ends of the concentration range for 2015.

- The 5th percentile for 2016 is at its lowest since 2005 (when the 5th percentile was zero due to non-detects). A review of the data shows that the number of carbon tetrachloride concentrations less than 0.4 µg/m^3 measured in 2016 (13) is at its highest in more than 10 years, accounting for 22 percent of measurements in 2016 (with concentrations of this magnitude accounting for fewer than 10 percent of measurements for most years since 2006).

Figure 20-19. Yearly Statistical Metrics for 1,2-Dichloroethane Concentrations Measured at BTUT



[1] A 1-year average is not presented due to low method completeness in 2015.

Observations from Figure 20-19 for 1,2-dichloroethane concentrations measured at BTUT include the following:

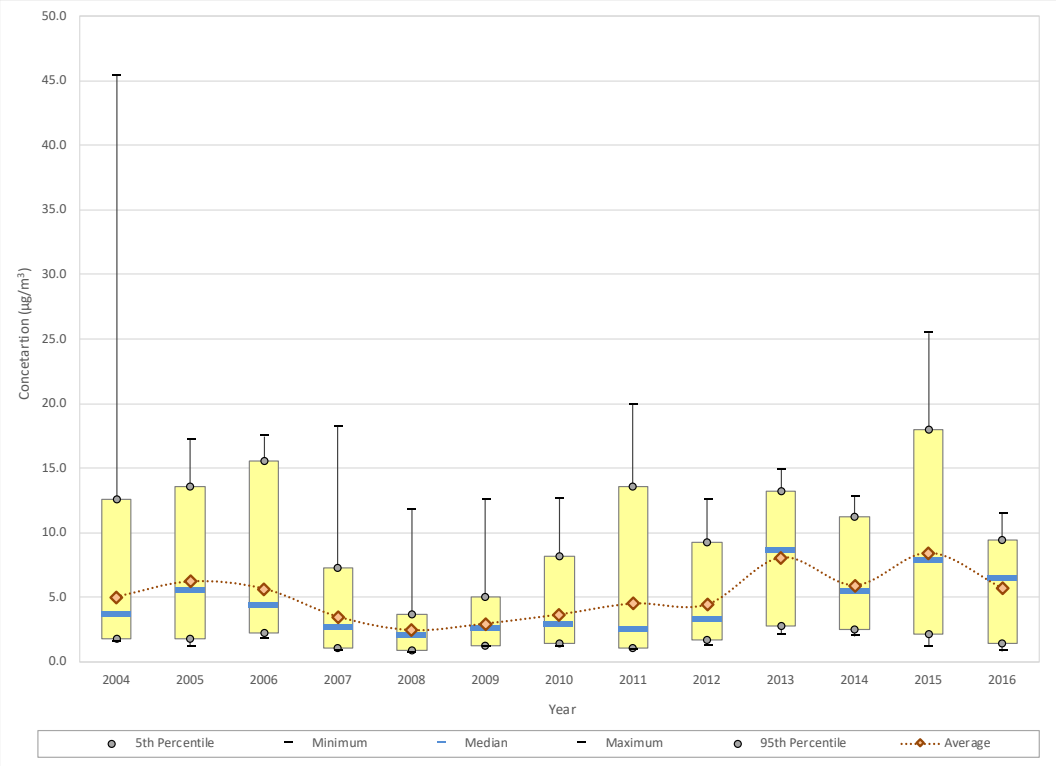
- For the first several years of sampling, all of the statistical parameters shown are zero, indicating that 1,2-dichloroethane was not detected. Between 2004 and 2008, there was a single measured detection of 1,2-dichloroethane, which was measured in 2007. Beginning with 2009, the number of measured detections began to increase; there were two measured detections in 2009, seven in 2010, 15 in 2011, and 47 in 2012, the first year with a median concentration greater than zero (indicating that there were more measured detections than non-detects for the first time since the onset of sampling). Between 2012 and 2016, the percentage of measured detections ranges from 71 percent (2013) to 98 percent (2014).

- The range of concentrations measured in 2013 is considerably larger than the range of concentrations measured in previous years, as the 1-year average concentration for 2013 is similar to the 95th percentile shown for previous years. All seven 1,2-dichloroethane concentrations greater than 0.25 µg/m^3 measured at BTUT were measured in 2013. Concentrations measured in 2013 account for more than 40 percent of the 29 1,2-dichloroethane concentrations greater than 0.15 µg/m^3 measured at BTUT since the onset of sampling.

- Little change is shown in the central tendency parameters between 2013 and 2014, despite the differences shown in the concentration profiles. 2014 is also the first year the 5th percentile is greater than zero, indicating that non-detects accounted for less than 5 percent of the measurements; a single non-detect was measured in 2014.

- Most of the statistical parameters exhibit decreases for 2015. Additional decreases are shown for some of the parameters for 2016, as the 5th percentile returns to zero. Although a 1-year average concentration is not available for 2015, median concentrations are available for both years. The median concentrations for both years are identical.

Figure 20-20. Yearly Statistical Metrics for Formaldehyde Concentrations Measured at BTUT



Observations from Figure 20-20 for formaldehyde concentrations measured at BTUT include the following:

- The maximum formaldehyde concentration (45.4 µg/m^3) was measured on August 31, 2004, on the same day that the highest acetaldehyde concentration was measured. This measurement is nearly twice the next highest concentration (25.5 µg/m^3), measured in 2015. Concentrations greater than 15 µg/m^3 were measured several times each year between 2004 and 2007, as well as in 2011 and 2015.

- Although the maximum concentration decreased significantly from 2004 to 2005, the other statistical metrics exhibit increases for 2005. The median increased by nearly 2 µg/m^3 from 2004 to 2005, indicating that concentrations were higher in 2005 than 2004 (as opposed to being driven by an outlier, as in 2004). To illustrate, the number of concentrations greater than 5 µg/m^3 increased from 11 measured in 2004 to 31 measured in 2005.

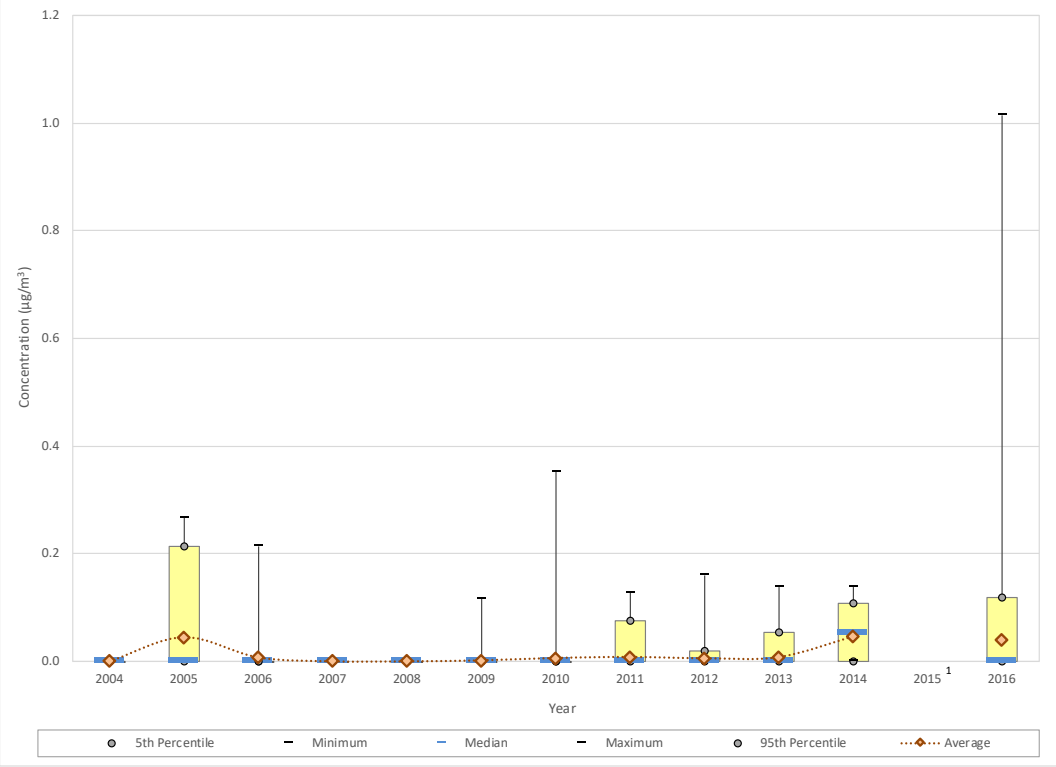
- After 2005, concentrations of formaldehyde measured at BTUT have a decreasing trend, with the 1-year average concentration decreasing from 6.21 µg/m^3 for 2005 to 2.44 µg/m^3 for 2008. In 2008, 95 percent of the concentrations measured were less than 4 µg/m^3, which is less than the 1-year average and/or median concentrations for several of the previous years. After 2008, a steady increasing trend is shown in the 1-year average formaldehyde concentrations, as well as most other statistical parameters, through 2011.

- Although little change is shown in the 1-year average concentration between 2011 and 2012 and the range of concentrations measured is smaller for 2012, the median concentration exhibits an increase. The decrease in the concentrations at the upper end of the range from 2011 to 2012 is balanced by a higher number of measurements at the mid-to-upper part of the range. The number of measurements greater than 10 µg/m^3 decreased from nine to one from 2011 to 2012 while the number of measurements between 5 µg/m^3 and 10 µg/m^3 increased from six to 14 during the same period. Also, six concentrations measured in 2011 are less than the minimum concentration measured in 2012.

- Significant increases are shown for the central tendency parameters for 2013, with all of the statistical parameters exhibiting increases. The 1-year average concentration nearly doubled and the median concentration increased by 160 percent from 2012. The number of formaldehyde concentrations greater than 10 µg/m^3 increased from one in 2012 to 16 in 2013, with concentrations greater than 5 µg/m^3 accounting for more than 75 percent of the measurements in 2013. This is also the only year for which a formaldehyde concentration less than 2 µg/m^3 was not measured.

- Significant decreases are shown for 2014, which is followed by significant increases again for 2015, when the second highest formaldehyde concentration was measured and when the 1-year average concentration is at a maximum (8.42 µg/m^3). The undulating pattern continues into 2016. The central tendency parameters calculated for the years between 2013 and 2016, though variable, are greater than most other years of sampling.

Figure 20-21. Yearly Statistical Metrics for Hexachloro-1,3-butadiene Concentrations Measured at BTUT



[1] A 1-year average is not presented due to a laboratory contamination issue affecting numerous samples.

Observations from Figure 20-21 for hexachloro-1,3-butadiene concentrations measured at BTUT include the following:

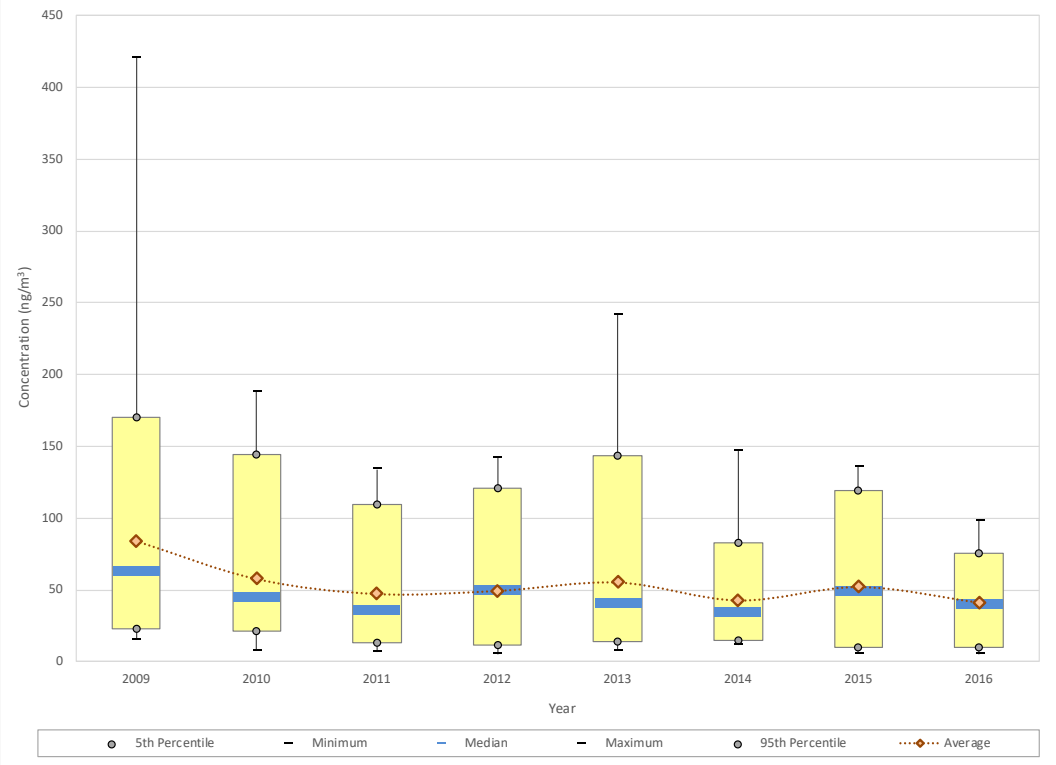
- The use of a contaminated internal standard at the laboratory for Method TO-15 resulted in the invalidation of the hexachloro-1,3-butadiene measurements from early March 2015 through mid-December 2015, as described in Section 2.4.

- The maximum hexachloro-1,3-butadiene concentration was measured at BTUT in 2016 (1.02 µg/m^3). Two additional concentrations greater than 0.25 µg/m^3 have been measured at BTUT since the onset of sampling (0.36 µg/m^3 in 2010 and 0.27 µg/m^3 in 2005).

- The median concentration of hexachloro-1,3-butadiene is zero for all years of sampling except 2014, indicating that at least half of the measurements were non-detects each year. There were no measured detections of this pollutant in 2004, 2007, and 2008 and there were five or fewer measured detections in 2006, each year between 2009 and 2013, and 2015 (as shown in Table 20-3). Hexachloro-1,3-butadiene was detected 12 times in 2005, 29 times in 2014, and 14 times in 2016.

- The magnitude of the maximum hexachloro-1,3-butadiene concentration measured in 2016 is balanced by the higher number of non-detects (or zeros) measured that year, such that the 1-year average concentrations for 2014 (0.045 µg/m^3) and 2016 (0.040 µg/m^3) are fairly similar to each other.

Figure 20-22. Yearly Statistical Metrics for Naphthalene Concentrations Measured at BTUT



Observations from Figure 20-22 for naphthalene concentrations measured at BTUT include the following:

- Although PAH sampling began at BTUT in April 2008, complications with the collection system lead to a 6-month lapse in sampling until mid-October. Thus, Figure 20-22 begins with 2009.

- The maximum naphthalene concentration (421 ng/m^3) was measured in 2009. The second highest naphthalene concentration (242 ng/m^3), measured in 2013, is the only other naphthalene measurement greater than 200 ng/m^3 measured at BTUT since the onset of PAH sampling.

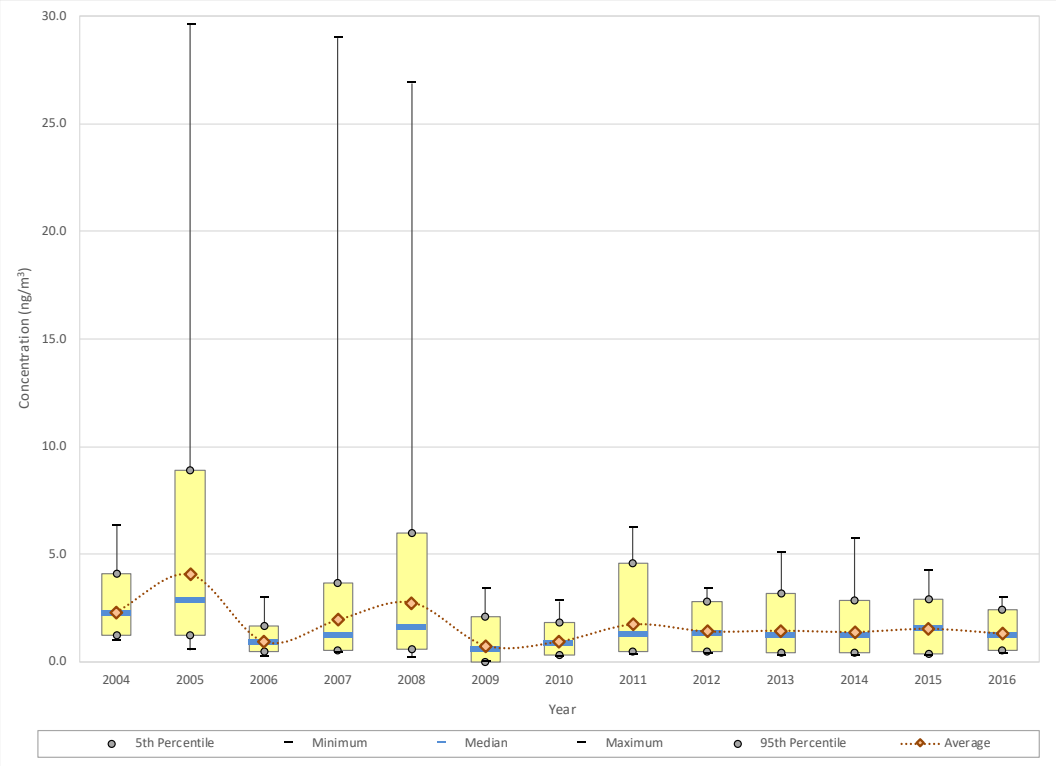
- A decreasing trend in naphthalene concentrations measured at BTUT is shown through 2011. Although little change in the range of measurements or the 1-year average concentration shown for 2012, the median concentration exhibits an increase. The biggest change in concentrations between the two years occurs in the middle of the concentration range. The number of naphthalene concentrations measured at BTUT between 50 ng/m^3 and 75 ng/m^3 increased from 11 to 20 from 2011 to 2012.

- After 2012, years when the majority of naphthalene concentrations fell into a wider range alternate with years when most naphthalene concentrations fell into a tighter range.

- Most of the statistical parameters are at a minimum for 2016, including the 1-year average concentration (41.44 ng/m^3). The maximum concentration is less than 100 ng/m^3 for the first time in 2016.

- Concentrations of naphthalene exhibit seasonality. Of the 51 naphthalene concentrations greater than 100 ng/m^3 measured at BTUT since 2009, all but four were measured during the first or fourth quarters of any given year, or the colder months of the year, with the majority measured in January (17), November (11), or December (16). Only one naphthalene concentration greater than 100 ng/m^3 has been measured at BTUT between April and August.

Figure 20-23. Yearly Statistical Metrics for Nickel (PM_{10}) Concentrations Measured at BTUT



Observations from Figure 20-23 for nickel concentrations measured at BTUT include the following:

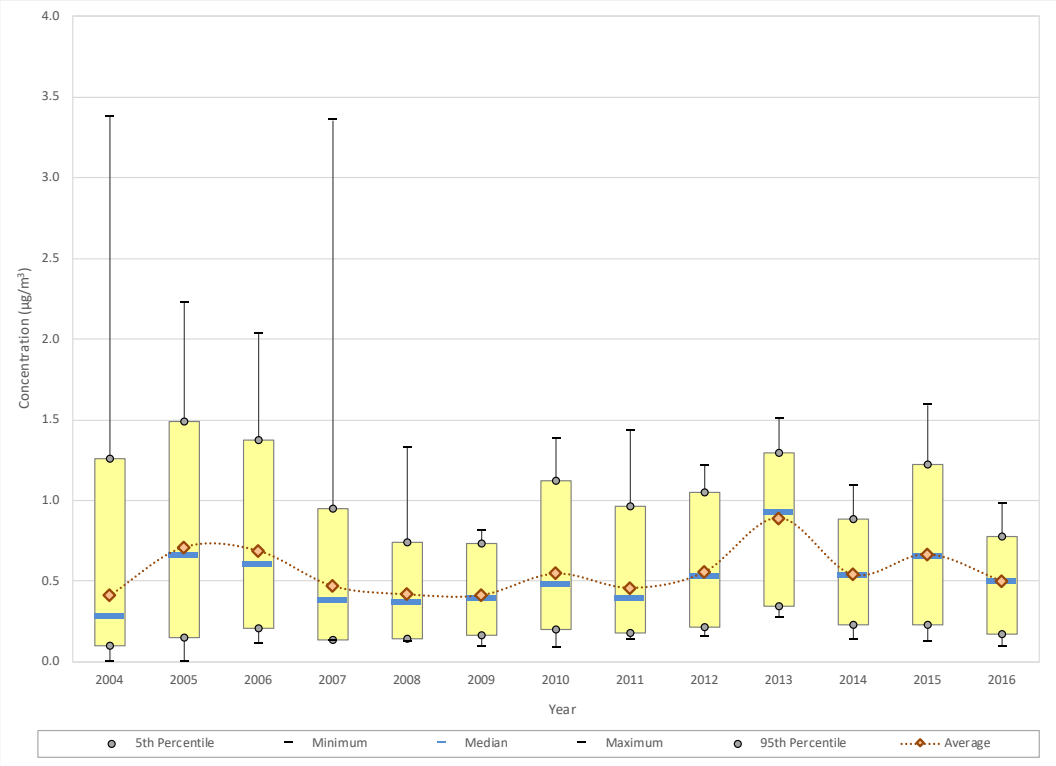
- The maximum nickel concentration was measured in 2005 (29.6 ng/m^3), although a similar concentration was also measured in 2007. Two additional nickel concentrations greater than 20 ng/m^3 were measured in 2008. Additional nickel concentrations greater than 10 ng/m^3 have not been measured at BTUT.

- All 24 non-detects of nickel were measured in 2009 and, with one exception, were measured on consecutive sample days between June and October.

- The range of nickel concentrations measured each year is highly variable, particularly through 2010. Concentrations measured over a given year have spanned a little as 2.57 ng/m^3 (2010) or to nearly 30 ng/m^3 (2005). This variability is reflected in the undulating pattern shown in the central tendency statistics, particularly in the years between 2004 and 2011. During this time period, the 1-year average concentrations ranged from 0.75 ng/m^3 (2009) to 4.05 ng/m^3 (2005).

- The concentrations measured between 2012 and 2016 exhibit less variability then the preceding years. The 1-year average concentrations calculated for each year during this period vary by less than 0.25 ng/m^3.

Figure 20-24. Yearly Statistical Metrics for Propionaldehyde Concentrations Measured at BTUT



Observations from Figure 20-24 for propionaldehyde concentrations measured at BTUT include the following:

- The maximum propionaldehyde concentration (3.38 µg/m^3) was measured in 2004, although a similar concentration (3.36 µg/m^3) was measured in 2007. The maximum propionaldehyde concentration was measured on August 31, 2004, the same day the highest acetaldehyde and formaldehyde concentrations were measured. An additional propionaldehyde concentration greater than 2 µg/m^3 was measured each year between 2004 and 2006.

- Although the range of propionaldehyde concentrations decreased somewhat from 2004 to 2005, both central tendency parameters exhibit an increase for 2005; the median concentration more than doubled during this time. The number of propionaldehyde concentrations greater than 0.5 µg/m^3 increased considerably from 2004 to 2005, increasing from nine measured in 2004 to 33 (accounting for more than half of the measurements collected in in 2005). A few additional propionaldehyde concentrations greater than 0.5 µg/m^3 were measured in 2006 (35).

- A significant decreasing trend in propionaldehyde concentrations is shown after 2006 through 2009, when the smallest range of concentrations was measured, although most of change occurred between 2006 and 2007.

- The range of concentrations measured nearly doubled from 2009 to 2010, with both central tendency parameters increasing significantly. Eight concentrations measured in 2010 were greater than the maximum propionaldehyde concentration measured in 2009; further, fewer concentrations less than 0.5 µg/m^3 were measured in 2009 (42) compared to 2010 (30). Although the range of concentrations measured changed little between 2010 and 2011, the number of concentrations less than 0.5 µg/m^3 returned to 2009 levels (43).

- A significant increasing trend in propionaldehyde concentrations is shown between 2011 and 2013. Both central tendency parameters are at a maximum for 2013. The number of propionaldehyde concentrations greater than 1 µg/m^3 is at its highest for 2013 (24); with the exceptions of 2005 and 2006, during which 13 concentrations greater than 1 µg/m^3 were measured, five or fewer were measured during each of the other years of sampling. Each of the carbonyl compounds exhibits an increase for 2013, as shown in Figures 20-14 and 20-20. A return to 2012 levels is shown for 2014.

- Years with "higher" concentrations continue to alternate with years with "lower" concentrations through 2016, though a return to 2013 levels has not occurred.

20.4 Additional Risk-Based Screening Evaluations

The following risk-based screening evaluations were conducted to characterize risk related to the air toxics measured at the BTUT monitoring site. Refer to Sections 3.2, 3.4.2.3, and 3.4.2.4 for definitions and explanations regarding the various toxicity factors, time frames, and calculations associated with these risk-based screenings.

20.4.1 Cancer Risk and Noncancer Hazard Approximations

For the pollutants of interest for BTUT, risk was examined by calculating cancer risk and noncancer hazard approximations for each year annual average concentrations could be calculated. These approximations can be used as risk estimates for cancer and noncancer effects attributable to the pollutants of interest. Although the use of these approximations is limited, they may help identify where policy-makers want to shift their air monitoring priorities. Refer to Section 3.4.2.3 for an explanation of how cancer risk and noncancer hazard approximations are calculated and what limitations are associated with them. Annual averages, cancer UREs and/or noncancer RfCs, and cancer risk and noncancer hazard approximations are presented in Table 20-4, where applicable. Cancer risk approximations are presented as probabilities while the noncancer hazard approximations are ratios and thus, unitless values.

Table 20-4. Risk Approximations for the Utah Monitoring Site

Pollutant	Cancer URE ($\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	2015				2016			
			# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Risk Approximations		# of Measured Detections vs. # of Samples	Annual Average ($\mu g/m^3$)	Risk Approximations	
					Cancer (in-a-million)	Noncancer (HQ)			Cancer (in-a-million)	Noncancer (HQ)
Bountiful, Utah - BTUT										
Acetaldehyde	0.0000022	0.009	54/54	3.64 ± 0.48	8.01	0.40	59/59	2.62 ± 0.31	5.76	0.29
Benzene	0.0000078	0.03	50/50	NA	NA	NA	59/59	0.72 ± 0.10	5.64	0.02
1,3-Butadiene	0.00003	0.002	47/50	NA	NA	NA	58/59	0.07 ± 0.01	2.13	0.04
Carbon Tetrachloride	0.000006	0.1	50/50	NA	NA	NA	59/59	0.56 ± 0.04	3.33	0.01
1,2-Dichloroethane	0.000026	2.4	47/50	NA	NA	NA	53/59	0.08 ± 0.01	2.19	<0.01
Formaldehyde	0.000013	0.0098	54/54	8.42 ± 1.37	109.51	0.86	59/59	5.68 ± 0.72	73.79	0.58
Hexachloro-1,3-butadiene	0.000022	0.09	3/50	NR	NR	NR	14/59	0.04 ± 0.04	0.89	<0.01
Propionaldehyde	--	0.008	54/54	0.67 ± 0.08	--	0.08	59/59	0.50 ± 0.05	--	0.06
Arsenic (PM_{10})[a]	0.0043	0.000015	58/60	0.70 ± 0.19	3.01	0.05	55/55	0.77 ± 0.23	3.30	0.05
Naphthalene[a]	0.000034	0.003	56/56	52.25 ± 8.19	1.78	0.02	61/61	41.44 ± 4.69	1.41	0.01
Nickel (PM_{10})[a]	0.00048	0.00009	60/60	1.53 ± 0.21	0.73	0.02	55/55	1.30 ± 0.15	0.62	0.01

[a] Average concentrations provided below the blue line for this pollutant are presented in ng/m^3 for ease of viewing.
NA = Not available because the criteria for calculating an annual average were not met.
NR = Not reportable due to invalidation related to a contaminated internal standard.
-- = A Cancer URE or Noncancer RfC is not available.

Observations for BTUT from Table 20-4 include the following:

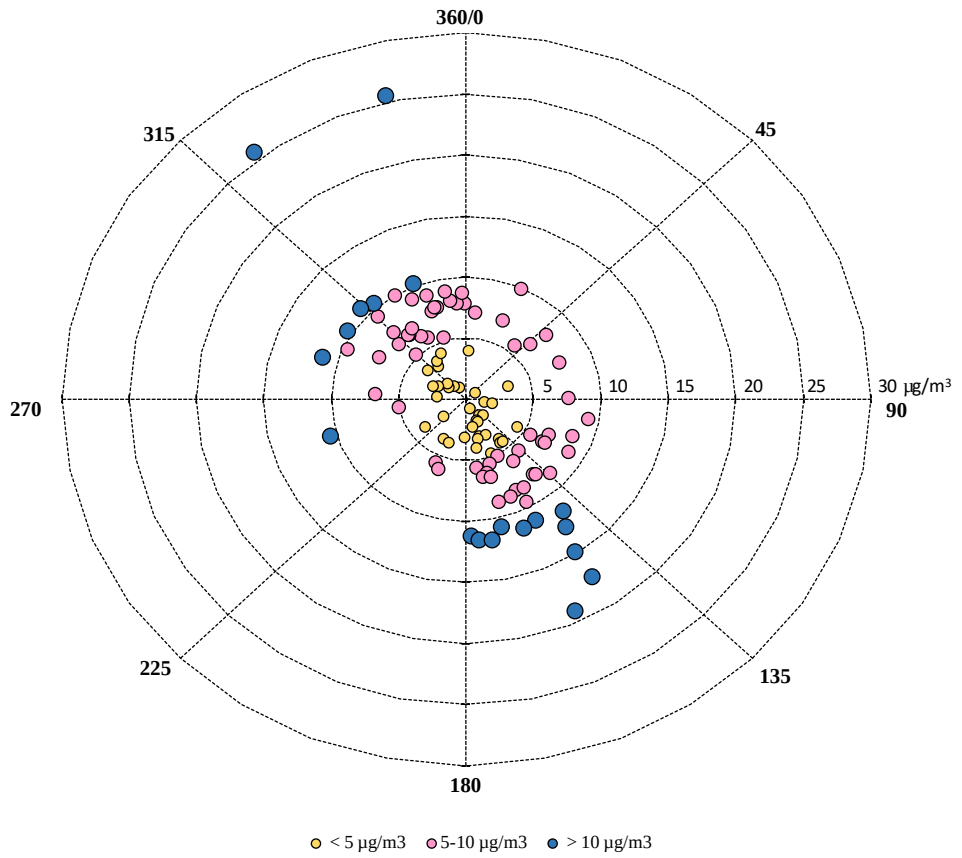
- Formaldehyde is the pollutant with the highest annual average concentrations for both years of sampling.

- Formaldehyde is also the pollutant with the highest cancer risk approximations for BTUT. Formaldehyde's cancer risk approximation for 2015 is 109.51 in-a-million, which is the highest cancer risk approximation across the program, and the only cancer risk approximation greater than 100 in-a-million. The remaining cancer risk approximations calculated for BTUT are all less than 10 in-a-million and most are less than 5 in-a-million.

- There were no pollutants of interest with noncancer hazard approximations greater than 1.0, indicating that no adverse noncancer health effects are expected from these individual pollutants. The highest noncancer hazard approximation was calculated for formaldehyde (0.86, 2015), which is also the highest noncancer hazard approximation calculated among the site-specific pollutants of interest with noncancer toxicity factors.

As an extension of this analysis, pollution roses were created for each of the site-specific pollutants of interest that have a cancer risk approximation greater than 75 in-a-million and/or a noncancer hazard approximation greater than 1.0, where applicable. Thus, a pollution rose was created for BTUT's formaldehyde measurements. A pollution rose is a plot of the ambient concentration versus the wind direction; the magnitude of the concentration is indicated using different colored dots and are shown in relation to the average wind direction oriented about a 16-point compass. Thus, high concentrations may be shown in relation to the direction of potential emissions sources. Hourly wind observations collected at the NWS station at the Salt Lake City International Airport and obtained from NOAA are used in this analysis and were averaged (using vector averaging techniques) to compute daily wind direction averages for comparison to the 24-hour concentration data. This analysis is intended to help identify the geographical area where emissions sources of these pollutants may have originated. Additional information regarding this analysis is also presented in Section 3.4.2.3. Figure 20-25 presents the pollution rose for all 113 formaldehyde concentrations measured at BTUT over the two-year sampling period.

Figure 20-25. Pollution Rose for Formaldehyde Concentrations Measured at BTUT



Observations from Figure 20-25 include the following:

- Formaldehyde concentrations of varying magnitude are shown in relation to varying average wind directions.

- The majority of the formaldehyde concentrations are shown in relation to sample days with an average wind direction from the southeast (51 of the 113 concentrations) and northwest (42) quadrants. Relatively few measurements were measured on sample days with an average wind direction from the northeast (11) and southwest (9) quadrants.

- For each concentration range shown on the pollution rose, the largest number of concentrations were associated with average winds from either the southeast or northwest quadrant. For example, among the 19 formaldehyde concentrations measured at BTUT greater than 10 µg/m^3 (indicated by the blue dots), 11 were measured on a sample day with an average wind direction within the southeast quadrant, more specifically, between 135º and 180º).

- The facility map in Figure 20-2 shows that most of the point sources within 10 miles of BTUT are located to the south and southwest of the site, along the I-15 corridor and towards Salt Lake City.

- If the formaldehyde concentrations are grouped by average compass direction using an 8-point compass, the direction with the most concentrations is southeast followed by northwest. If the formaldehyde concentrations are averaged by compass direction using an 8-point compass, the highest average concentration is calculated for north. The northerly direction includes one formaldehyde concentration less than 5 µg/m^3, two formaldehyde concentrations greater than 10 µg/m^3 (including one greater than 25 µg/m^3), and 13 in between.

- The wind data for many of the sample days reflect a lake breeze/valley breeze system, one in which the wind direction in the morning is different from the afternoon/evening, switching directions with regularity due to daytime heating and geographic features such as the Great Salt Lake and the mountains on either side of the Salt Lake Valley (NHMU, 2018).

20.4.2 Risk-Based Emissions Assessment

In addition to the risk-based screening discussed above, this section presents an evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 20-5 presents the 10 pollutants with the highest emissions from the 2014 NEI (version 1) that have cancer toxicity factors. Table 20-5 also presents the 10 pollutants with the highest toxicity-weighted emissions, based on the weighting schema described in Section 3.4.2.4. Lastly, Table 20-5 provides the pollutants of interest with the highest cancer risk approximations (in-a-million) for BTUT, as presented in Table 20-4. Cancer risk approximations for 2015 are presented in green while approximations for 2016 are in white. The emissions, toxicity-weighted emissions, and cancer risk approximations are shown in descending order in Table 20-5. Table 20-6 presents similar information, but is limited to those pollutants with noncancer toxicity factors.

Because not all pollutants have both cancer and noncancer toxicity factors, the highest emitted pollutants in the cancer table may be different from the noncancer table, although the actual quantity of emissions is the same. The cancer risk and noncancer hazard approximations based on each site's annual averages are limited to the pollutants of interest identified for each site. In addition, the cancer risk and noncancer hazard approximations are limited to those pollutants with enough data to meet the criteria for annual averages to be calculated. A more in-depth discussion of this analysis is provided in Section 3.4.2.4. Similar to the cancer risk and noncancer hazard approximations provided in Section 20.4.1, this analysis may help policy-makers prioritize their air monitoring activities.

Table 20-5. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Utah Monitoring Site

Top 10 Total Emissions for Pollutants with Cancer UREs (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Bountiful, Utah (Davis County) - BTUT					
Benzene	80.80	Formaldehyde	9.84E-04	Formaldehyde	109.51
Formaldehyde	75.69	Hexavalent Chromium, PM	7.51E-04	Formaldehyde	73.79
Ethylbenzene	47.83	Benzene	6.30E-04	Acetaldehyde	8.01
Acetaldehyde	39.64	Naphthalene	3.69E-04	Acetaldehyde	5.76
Dichloromethane	18.27	1,3-Butadiene	3.48E-04	Benzene	5.64
Tetrachloroethylene	12.20	POM, Group 2b	1.60E-04	Carbon Tetrachloride	3.33
1,3-Butadiene	11.61	Nickel, PM	1.24E-04	Arsenic	3.30
Naphthalene	10.86	Ethylbenzene	1.20E-04	Arsenic	3.01
POM, Group 2b	1.82	POM, Group 2d	1.13E-04	1,2-Dichloroethane	2.19
POM, Group 2d	1.29	Acetaldehyde	8.72E-05	1,3-Butadiene	2.13

[1]Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Table 20-6. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the Utah Monitoring Site

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Hazard Approximation (HQ)**
Bountiful, Utah (Davis County) - BTUT					
Toluene	305.13	Acrolein	300,503.52	Formaldehyde	0.86
Xylenes	178.94	Chlorine	19,043.33	Formaldehyde	0.58
Methanol	147.88	Formaldehyde	7,723.68	Acetaldehyde	0.40
Benzene	80.80	1,3-Butadiene	5,803.27	Acetaldehyde	0.29
Hexane	77.67	Acetaldehyde	4,403.90	Propionaldehyde	0.08
Formaldehyde	75.69	Naphthalene	3,618.63	Propionaldehyde	0.06
Ethylene glycol	57.74	Nickel, PM	2,862.10	Arsenic	0.05
Ethylbenzene	47.83	Benzene	2,693.47	Arsenic	0.05
Acetaldehyde	39.64	Xylenes	1,789.40	1,3-Butadiene	0.04
Dichloromethane	18.27	Lead, PM	1,009.88	Benzene	0.02

[1]Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Observations from Table 20-5 include the following:

- Benzene, formaldehyde, and ethylbenzene are the highest emitted pollutants with cancer UREs in Davis County.

- The pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) are formaldehyde, hexavalent chromium, and benzene.

- Eight of the highest emitted pollutants also have the highest toxicity-weighted emissions in Davis County.

- Formaldehyde, which has the highest cancer risk approximations for BTUT, ranks second for quantity emitted and first for its toxicity-weighted emissions. Acetaldehyde, benzene, and 1,3-butadiene also appear on all three lists in Table 20-5. Arsenic, carbon tetrachloride, and 1,2-dichloroethane, the remaining pollutants of interest listed for BTUT, appear on neither emissions-based list.

- POM, Groups 2b and 2d appear on both emissions-based lists in Table 20-5. POM, Group 2b includes several PAHs sampled for at BTUT, including acenaphthene and fluorene, which failed a few screens but were not identified as pollutants of interest for BTUT. POM, Group 2d does not include any of the PAHs sampled for at BTUT.

Observations from Table 20-6 include the following:

- Toluene, xylenes, and methanol are the highest emitted pollutants with noncancer RfCs in Davis County.

- The pollutants with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) are acrolein, chlorine, and formaldehyde. Although acrolein was sampled for at BTUT, this pollutant was excluded from the pollutants of interest designation, and thus subsequent risk-based screening evaluations, due to questions about the consistency and reliability of the measurements, as discussed in Section 3.2.

- Four of the highest emitted pollutants also have the highest toxicity-weighted emissions in Davis County.

- The carbonyl compound pollutants of interest (formaldehyde, followed by acetaldehyde, and propionaldehyde) have the highest noncancer hazard approximations for BTUT (although all are less than 1.0). Formaldehyde and acetaldehyde both appear on both emissions-based lists, while propionaldehyde does not.

- Benzene, 1,3-butadiene, and arsenic are also among the pollutants of interest with the highest noncancer hazard approximations for BTUT. Benzene also appears on both emissions-based lists while 1,3-butadiene ranks among the pollutants with the highest toxicity-weighted emissions in Davis County but does not appear among those with the highest total emissions. Arsenic does not appear on either emissions-based list.

20.5 Summary of the 2015-2016 Monitoring Data for BTUT

Results from several of the data analyses described in this section include the following:

- *Twenty-two pollutants failed at least one screen for BTUT.*
- *Formaldehyde had the highest annual average concentrations among the pollutants of interest for BTUT, followed by acetaldehyde.*
- *For the fifth year in a row, BTUT has the highest annual average formaldehyde concentration (2015) among NMP sites sampling this pollutant.*
- *Concentrations of benzene have an overall decreasing trend at BTUT; the 1-year average concentration for 2016 is the lowest 1-year average concentration of benzene calculated since the onset of sampling at BTUT. Concentrations of 1,3-butadiene and naphthalene have also decreased in recent years.*
- *The cancer risk approximation calculated for formaldehyde, based on the annual average concentration for 2015, is the highest cancer risk approximation across the program. None of the pollutants of interest for BTUT have noncancer hazard approximations greater than an HQ of 1.0.*

21.0 Site in Vermont

This section summarizes those data from samples collected at the NATTS site in Vermont and generated by ERG, EPA's contract laboratory for the NMP, over the 2015 and 2016 monitoring efforts. This section also examines the spatial and temporal characteristics of the ambient monitoring concentrations and reviews them through the context of risk. Readers are encouraged to refer to Sections 1 through 4 for detailed discussions and definitions regarding the various data analyses presented below.

Data generated by sources other than ERG, EPA's contract laboratory for the NMP, are not included in the data analyses contained in this report.

21.1 Site Characterization

This section characterizes the Vermont monitoring site by providing a description of the nearby area surrounding the monitoring site; plotting emissions sources surrounding the monitoring site; and presenting traffic data and other characterizing information for the site. This information is provided to give the reader insight regarding factors that may influence the air quality near the site and assist in the interpretation of the ambient measurements.

The Vermont NATTS site (UNVT) is located in the town of Underhill, in northwest Vermont, in the Burlington-South Burlington, VT CBSA. Figure 21-1 presents a composite satellite image retrieved from ArcGIS Explorer showing the Underhill monitoring site and its immediate surroundings. Figure 21-2 identifies nearby point source emissions locations by source category, as reported in the 2014 NEI for point sources, version 1. Note that only sources within 10 miles of the site are included in the facility counts provided in Figure 21-2. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have a direct effect on the air quality at the monitoring site. Further, this boundary provides both the proximity of emissions sources to the monitoring site as well as the quantity of such sources within a given distance of the site. Sources outside the 10-mile boundary are still visible on the map for reference but have been grayed out to emphasize emissions sources within the boundary. Table 21-1 provides supplemental geographical information such as land use, location setting, and locational coordinates for the site. Each figure and table is discussed in detail in the paragraphs that follow.

Figure 21-1. Underhill, Vermont (UNVT) Monitoring Site

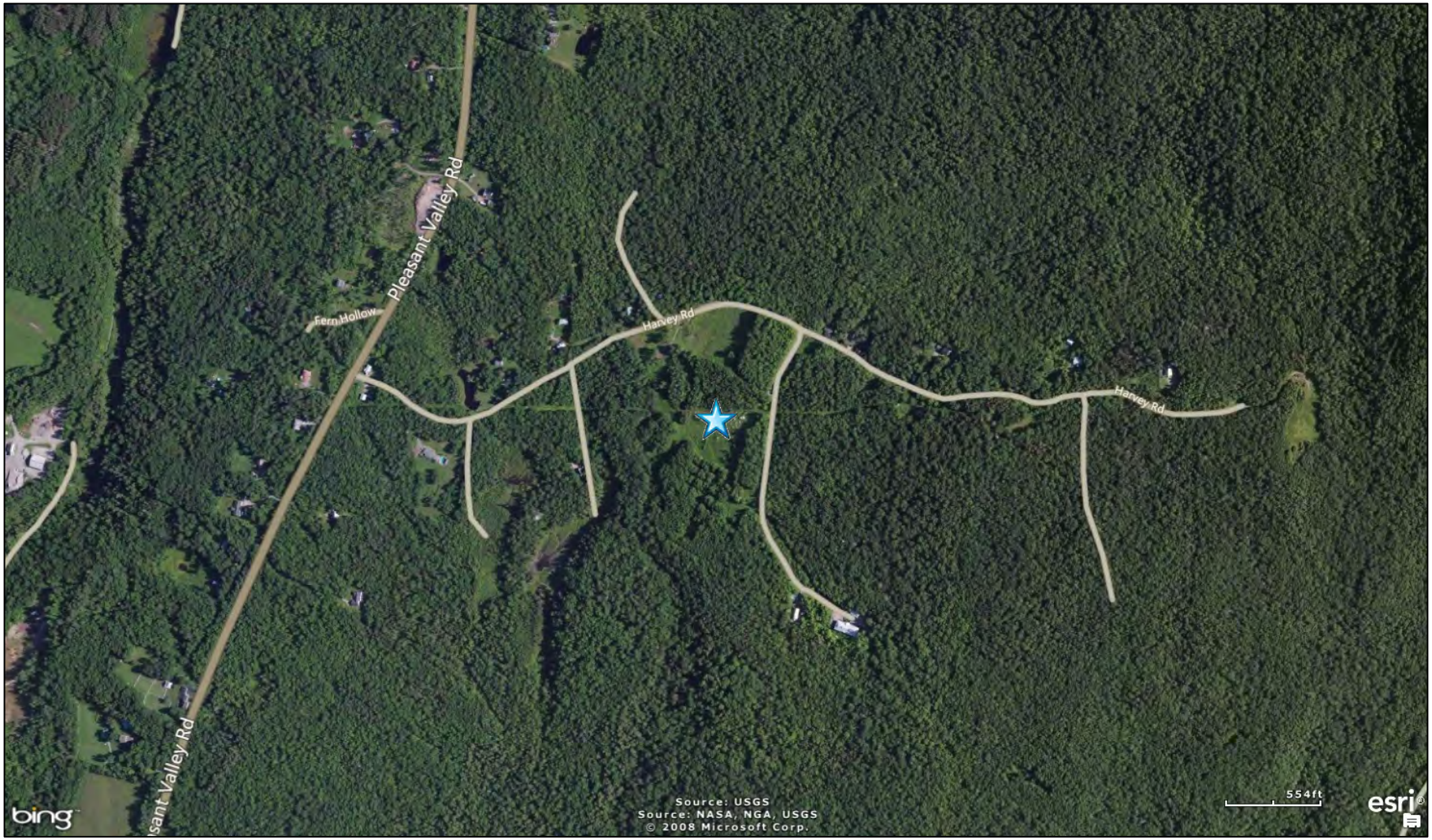


Figure 21-2. NEI Point Sources Located Within 10 Miles of UNVT

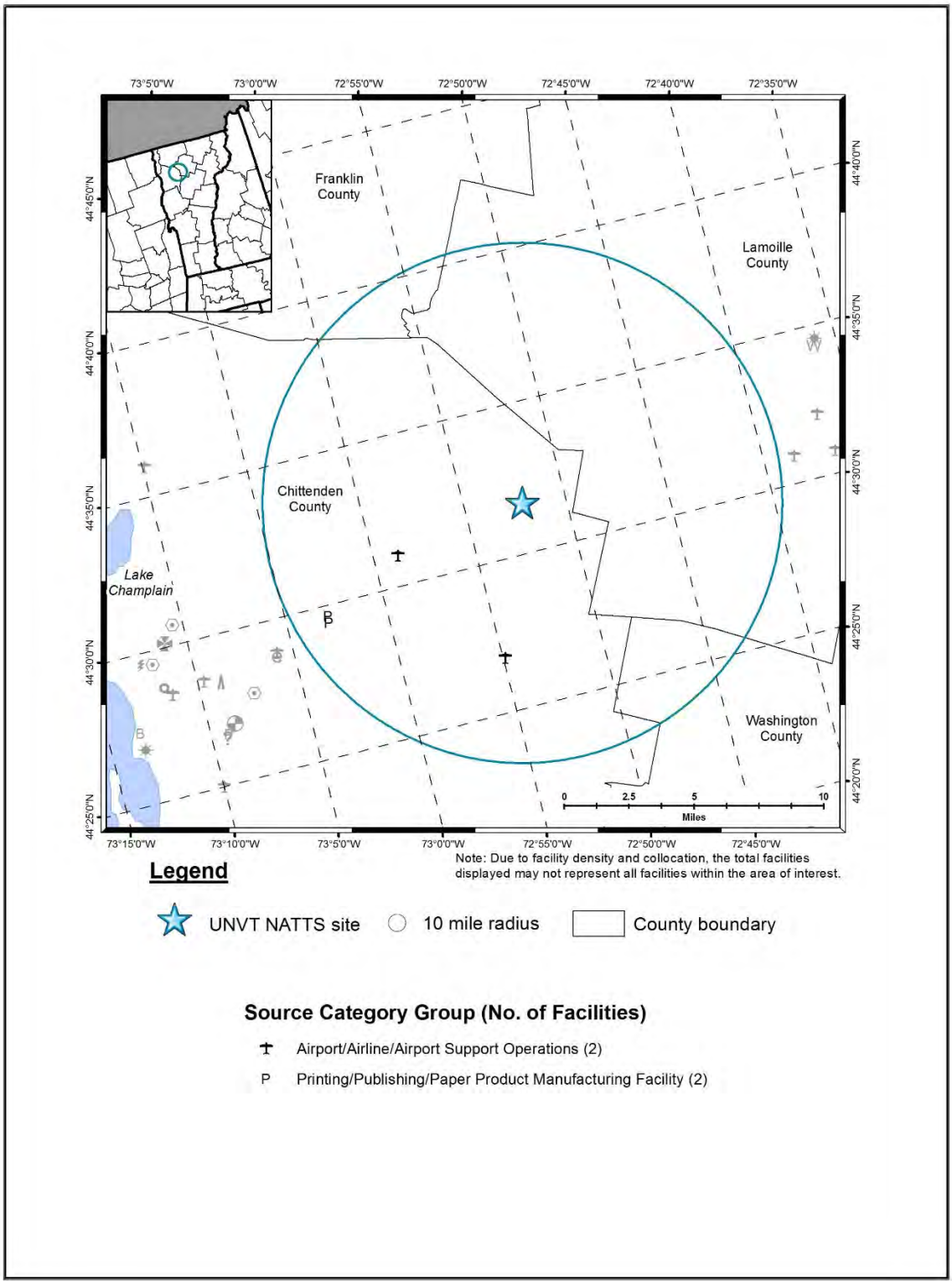


Table 21-1. Geographical Information for the Vermont Monitoring Site

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Annual Average Daily Traffic[1]	Intersection Used for Traffic Data
UNVT	50-007-0007	Underhill	Chittenden	Burlington-South Burlington, VT	44.528390, -72.868840	Forest	Rural	970	Pleasant Valley Rd, North of Harvey Rd

[1]AADT reflects 2014 data for UNVT (Vtrans, 2015)
BOLD ITALICS = EPA-designated NATTS Site

The UNVT monitoring site is located on the Proctor Maple Research Center in Underhill, Vermont, which is east of the Burlington area. This research station is part of the University of Vermont, with research focused on the sugar maple tree and sap collection methods (UVM, 2015). Figure 21-1 shows that the area surrounding the site is rural in nature and heavily forested. Mount Mansfield, the highest peak in Vermont, lies to the east in Underhill State Park, less than 3 miles away. This site is intended to serve as a regional background site for trends assessment, standards compliance, and long-range transport assessment.

Most of the emissions sources near UNVT are located to the west and southwest of the monitoring site, primarily closer to the Burlington area. The closest sources to UNVT are both in the airport source category, which includes airports and related operations as well as small runways and heliports, such as those associated with hospitals or television stations. These two sources are private airports. Two sources in the printing and publishing source category are also located within 10 miles of UNVT.

In addition to providing city, county, CBSA, and land use/location setting information, Table 21-1 also contains traffic volume information for the site as well as the location for which the traffic volume was obtained. This information is provided because emissions from motor vehicles can significantly affect concentrations measured at a given monitoring site. The traffic volume near UNVT is relatively light, with less than 1,000 vehicles passing near UNVT on a daily basis. The traffic estimate near UNVT is the third lowest compared to other NMP sites. The traffic estimate for UNVT is provided for Pleasant Valley Road, north of Harvey Road.

21.2 Pollutants of Interest

The risk-based screening process described in Section 3.2 was performed for each site in order to identify site-specific "pollutants of interest," which allows analysts and readers to focus on a subset of pollutants through the context of risk. Each pollutant's preprocessed daily measurement was compared to its associated risk screening value. If the concentration was greater than the risk screening value, then the concentration "failed the screen." The site-specific results of this risk-based screening process are presented in Table 21-2 and incorporate measurements from both 2015 and 2016. Pollutants of interest are those for which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens and are shaded in gray in Table 21-2. It is important to note which pollutants were sampled for at each site when reviewing the results of this analysis. PAHs were sampled for at UNVT under the NMP in 2015 and 2016.

Table 21-2. 2015-2016 Risk-Based Screening Results for the Vermont Monitoring Site

Pollutant	Screening Value (µg/m^3)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Underhill, Vermont - UNVT						
Benzo(a)pyrene	0.00057	1	41	2.44	50.00	50.00
Naphthalene	0.029	1	121	0.83	50.00	100.00
Total		2	162	1.23		

Observations from Table 21-2 include the following:

- Two individual concentrations failed screens for UNVT.
- Of the 41 measured detections of benzo(a)pyrene, one concentration failed a screen, representing a 2 percent failure rate. Of the 121 measured detections of naphthalene, one concentration failed a screen, representing less than a 1 percent failure rate.
- Because these two pollutants contributed equally to the total number of failed screens (two), they are both considered pollutants of interest for UNVT. UNVT is one of only two NMP sites with benzo(a)pyrene as a pollutant of interest.
- UNVT has the fewest failed screens of any NMP site (by a considerable margin), as shown in Table 4-9.

For each of the data analyses described in the remaining sections, the focus is on the site-specific pollutants of interest identified via the risk-based screening process, as described in Section 3.4.2.

21.3 Concentrations

This section presents various concentration averages used to characterize air toxics concentration levels at the Vermont monitoring site. Where applicable, the following calculations and data analyses were performed for each of the site-specific pollutants of interest:

- Time period-based concentration averages (quarterly and annual) are provided for each monitoring site for each year of sampling.
- The range of measurements and annual average concentrations are presented graphically for each site to illustrate how the site's concentrations compare to the program-level averages, as presented in Section 4.1.
- Concentration averages and other statistical metrics for 2015, 2016, and from previous years of monitoring are presented in order to characterize concentration trends at each site.

Each data analysis is performed where the applicable criteria are met (as specified in the appropriate sections discussed below) and is limited to the site-specific pollutants of interest. However, site-specific statistical summaries for all pollutants sampled for at UNVT are provided in Appendix N.

21.3.1 2015 and 2016 Concentration Averages

Quarterly and annual concentration averages for 2015 and 2016 were calculated for the pollutants of interest for the UNVT site, as described in Section 3.1. The *quarterly average concentration* of a particular pollutant is simply the average concentration of the preprocessed daily measurements over a given calendar quarter. Quarterly average concentrations include the substitution of zeros for all non-detects. A site must have a minimum of 75 percent valid samples compared to the total number of samples possible within a given calendar quarter for a quarterly average to be calculated. An *annual average concentration* includes all measured detections and substituted zeros for non-detects for an entire year of sampling. Annual averages were calculated for pollutants where three valid quarterly averages could be calculated for a given year and where method completeness was greater than or equal to 85 percent, as presented in Section 2.4. Quarterly and annual average concentrations for the pollutants of interest for the UNVT monitoring site are presented in Table 21-3, where applicable. Note that if a pollutant was not detected in a given calendar quarter, the quarterly average simply reflects “0” because only zeros substituted for non-detects were factored into the quarterly average concentration.

Table 21-3. Quarterly and Annual Average Concentrations of the Pollutants of Interest for the Vermont Monitoring Site

Pollutant	2015						2016					
	# of Detects/ # >MDL/ # Samples	Q1 Avg (ng/m^3)	Q2 Avg (ng/m^3)	Q3 Avg (ng/m^3)	Q4 Avg (ng/m^3)	Annual Average (ng/m^3)	# of Detects/ # >MDL/ # Samples	Q1 Avg (ng/m^3)	Q2 Avg (ng/m^3)	Q3 Avg (ng/m^3)	Q4 Avg (ng/m^3)	Annual Average (ng/m^3)
Underhill, Vermont - UNVT												
Benzo(a)pyrene	19/0/60	0.04 ± 0.02	0.01 ± 0.01	0.01 ± 0.01	0.01 ± 0.01	0.02 ± 0.01	22/3/61	0.03 ± 0.02	0.06 ± 0.12	0	0.01 ± 0.01	0.03 ± 0.03
Naphthalene	60/60/60	17.56 ± 3.99	5.97 ± 1.85	6.58 ± 2.95	9.39 ± 2.68	9.87 ± 1.83	61/61/61	12.12 ± 2.09	5.86 ± 1.24	4.87 ± 0.81	10.44 ± 2.66	8.39 ± 1.17

Observations from Table 21-3 include the following:

- Benzo(a)pyrene was detected in 34 percent of samples collected over the two-year period but was detected over the MDL only three times (all of which were measured in 2016).

- Concentrations of benzo(a)pyrene measured at UNVT range from 0.0074 ng/m^3 to 0.860 ng/m^3, with 80 non-detects. A total of five benzo(a)pyrene concentrations greater than 0.1 ng/m^3 were measured at UNVT; two concentrations between 0.10 ng/m^3 and 0.15 ng/m^3 were measured during the first quarter of each year, plus the maximum concentration, which was measured in June 2016.

- Measured detections of benzo(a)pyrene were measured during every calendar quarter except during the third quarter of 2016. In 2015, 13 of the 19 measured detections were measured during the first quarter of the year, with two each measured during each of the other three calendar quarters. In 2016, most of the measured detections were measured during the first (nine) and fourth (10) quarters of the year, with three measured during the second and none measured during the third. The maximum benzo(a)pyrene concentration measured at UNVT was measured on June 26, 2016 (0.860 ng/m^3) and is nearly eight time greater than the next highest concentration measured at UNVT; the magnitude of this measurement is reflected in the second quarter average concentration for 2016 (0.06 ± 0.12 ng/m^3).

- Naphthalene was detected in all 121 valid PAH samples collected in 2015 and 2016. Concentrations of naphthalene measured at UNVT range from 2.64 ng/m^3 to 34.5 ng/m^3. The annual average for 2015 (9.87 ± 1.83 ng/m^3) is higher than the annual average for 2016 (8.39 ± 1.17 ng/m^3), though the difference is not statistically significant.

- For 2015, the first quarter average concentration of naphthalene is significantly higher than the other quarterly average concentrations. Nine of the 12 naphthalene concentrations greater than 15 ng/m^3 measured in 2015 were measured during the first calendar quarter (with none measured during the second quarter, one during the third, and two during the fourth). Additionally, none of the 20 naphthalene concentrations less than 5 ng/m^3 were measured during the first quarter of 2015.

- For 2016, the first and fourth quarter average concentrations of naphthalene are higher than the quarterly averages for the second and third quarters of the year. Nineteen of the 21 naphthalene concentrations greater than 10 ng/m^3 were measured during the first or fourth calendar quarters (with the other two measured in April). Additionally, none of the 18 naphthalene concentrations less than 5 ng/m^3 were measured during the first quarter of 2016 and only one was measured during the fourth quarter.

- Among NMP sites sampling PAHs, UNVT has the lowest annual average concentrations of naphthalene. This is also true for benzo(a)pyrene.

21.3.2 Concentration Comparison

In order to better illustrate how a site's annual average concentrations compare to the program-level averages, a site-specific box plot was created for each of the site-specific pollutants of interest, where applicable. Thus, box plots were created for the pollutants listed in Table 21-3 for UNVT. Figure 21-3 overlays the site's minimum, annual average, and maximum concentrations for each year onto the program-level minimum, first quartile, median, average, third quartile, and maximum concentrations, as described in Section 3.4.2.1, and are discussed below. If an annual average concentration could not be calculated, the range of concentrations are still provided in the figures that follow.

Figure 21-3. Program vs. Site-Specific Average Benzo(a)pyrene Concentrations

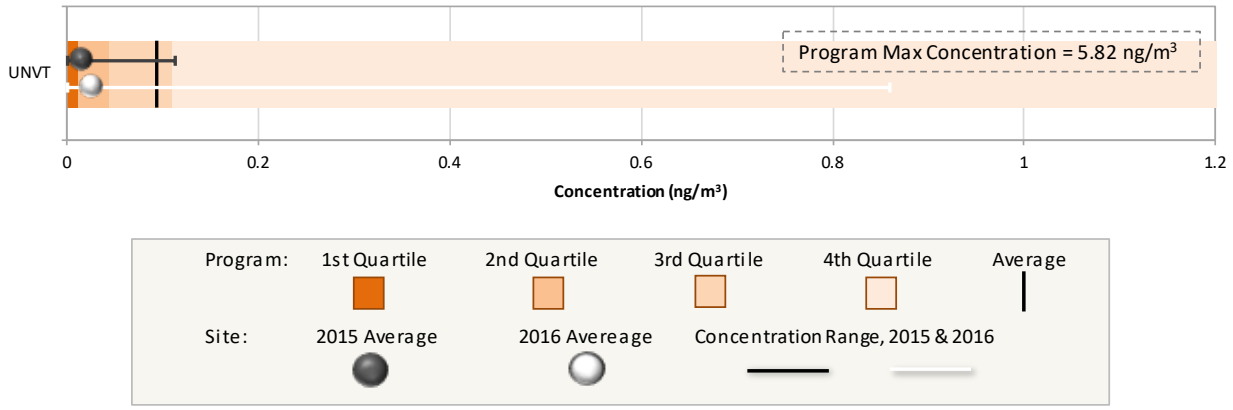


Figure 21-3 presents the box plot for benzo(a)pyrene for UNVT and shows the following:

- The program-level maximum benzo(a)pyrene concentration (5.82 ng/m^3) is not shown directly on the box plot in Figure 21-3 because the scale of the box plot would be too large to readily observe data points at the lower end of the concentration range. Thus, the scale of the box plot has been reduced to 1.2 µg/m^3.

- Although the maximum benzo(a)pyrene concentration measured at UNVT is considerably less than the maximum concentration measured across the program, it is the 15th highest concentration measured across the program. If this concentration is excluded, the range of concentrations measured each year at UNVT would be similar to each other.

- Both annual average concentrations for UNVT are greater than the program-level first quartile and less than the program-level median concentration.

Figure 21-4. Program vs. Site-Specific Average Naphthalene Concentrations

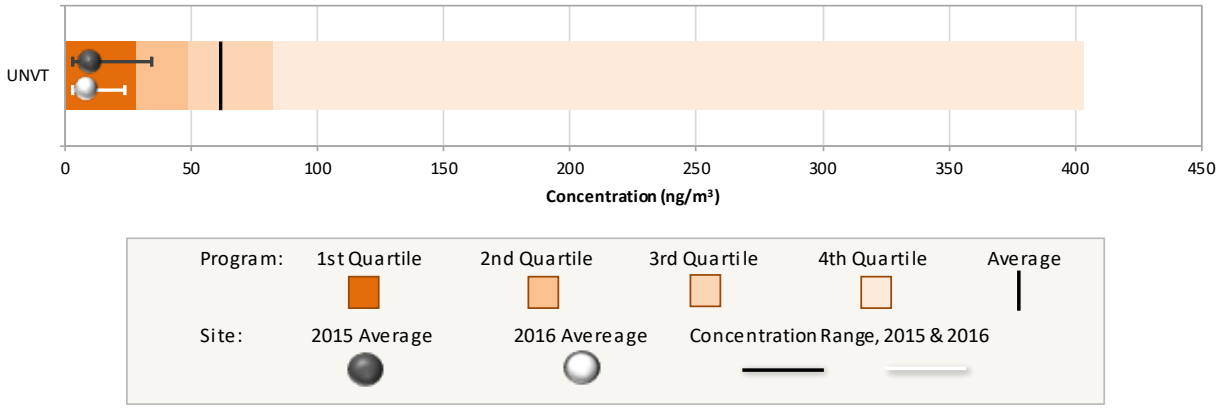


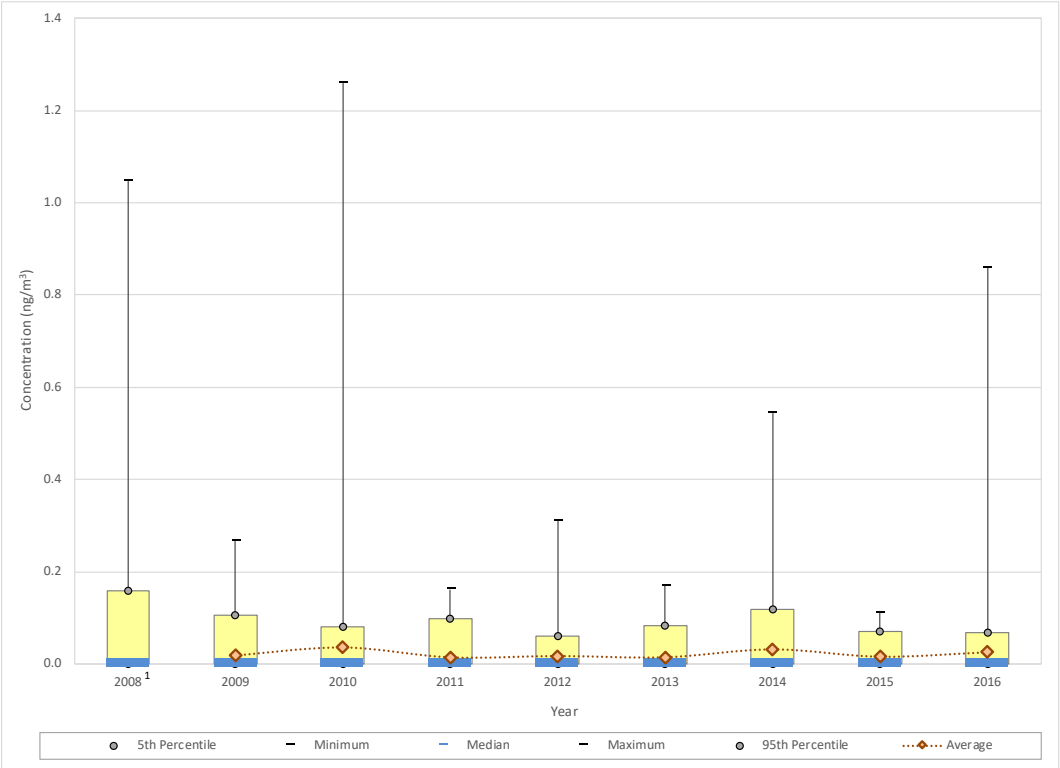
Figure 21-4 presents the box plot for naphthalene for UNVT and shows the following:

- The maximum naphthalene concentration measured at UNVT (34.5 ng/m^3) is an order of magnitude less than the program-level maximum naphthalene concentration (403 ng/m^3).
- The entire range of naphthalene concentrations measured at UNVT in 2016 is less than the program-level first quartile (28.3 ng/m^3) and only one concentration measured in 2015 is greater than the first quartile.
- UNVT is the only NMP site for which an annual average concentration of naphthalene less than 10 ng/m^3 was calculated.

21.3.3 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the pollutants of interest for 5 consecutive years or longer, as described in Section 3.4.2.2. UNVT has sampled PAHs under the NMP since 2008. Thus, Figures 21-5 and 21-6 present the 1-year statistical metrics for the pollutants of interest for UNVT. The statistical metrics presented for assessing trends include the substitution of zeros for non-detects. If sampling began mid-year, a minimum of 6 months of sampling is required for inclusion in the trends analysis; in these cases, a 1-year average concentration is not provided, although the range and percentiles are still presented.

Figure 21-5. Yearly Statistical Metrics for Benzo(a)pyrene Concentrations Measured at UNVT



[1] A 1-year average is not presented because sampling under the NMP did not begin until June 2008.

Observations from Figure 21-5 for benzo(a)pyrene concentrations measured at UNVT include the following:

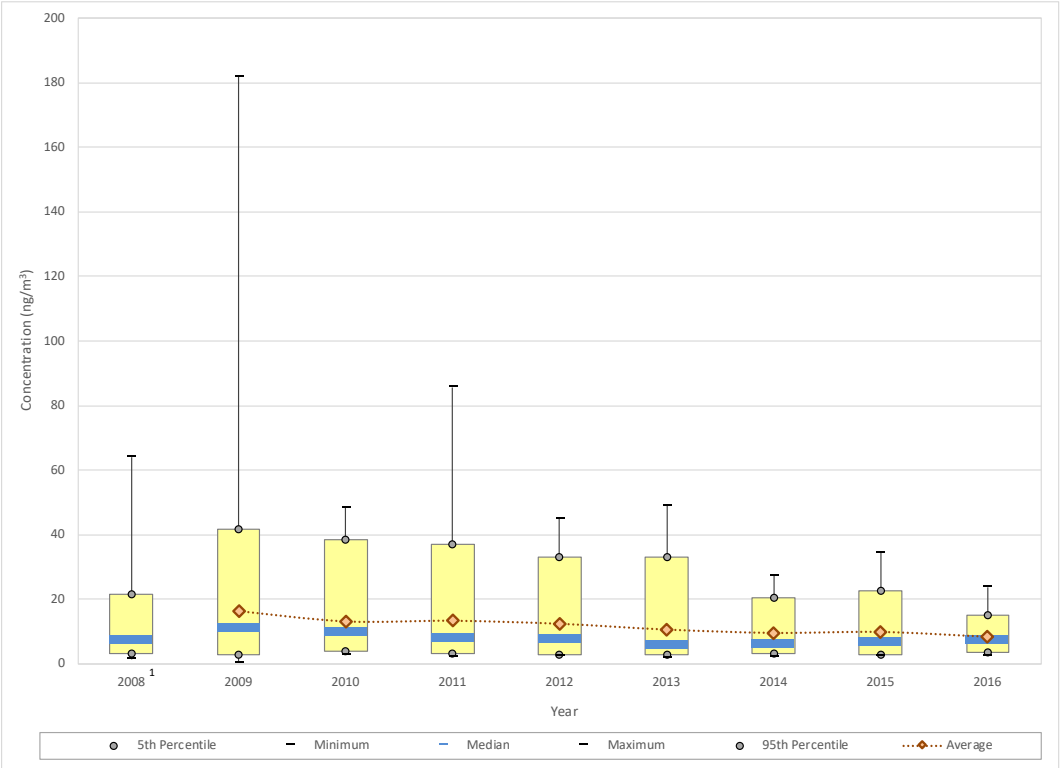
- UNVT began sampling PAHs under the NMP in June 2008. Because a full year's worth of data is not available, a 1-year average for 2008 is not presented, although the range of measurements is provided.

- The median benzo(a)pyrene concentration for each year of sampling is zero, indicating that non-detects account for at least half of the measurements each year at UNVT.

- The range of benzo(a)pyrene concentrations measured each year is highly variable, with a year with a "higher" concentration or two alternating with a year with "lower" concentrations. In total, six benzo(a)pyrene concentrations greater than 0.3 ng/m^3 have been measured at UNVT; five of these are visible as the maximum concentrations for 2008, 2010, 2012, 2014, and 2016, with the sixth also measured in 2010.

- The 1-year average concentration has ranged from 0.014 ng/m^3 (2011, 2014) to 0.037 ng/m^3 (2010) over the years of sampling.

Figure 21-6. Yearly Statistical Metrics for Naphthalene Concentrations Measured at UNVT



[1] A 1-year average is not presented because sampling under the NMP did not begin until June 2008.

Observations from Figure 21-6 for naphthalene concentrations measured at UNVT include the following:

- A single naphthalene concentration greater than 100 ng/m^3 has been measured at UNVT (186 ng/m^3). In total, only six concentrations greater than 50 ng/m^3 have been measured at this site, three in 2011, two in 2009, and one in 2008. Naphthalene concentrations greater than 35 ng/m^3 have not been measured since 2013.

- A significant decreasing trend in naphthalene concentrations measured at UNVT is shown in Figure 21-6. The 1-year average concentration, the 95th percentile, and maximum concentration are all at a minimum for 2016.

- The 1-year average concentration has decreased by nearly half since 2009, from 16.38 ng/m^3 in 2009 to 8.39 ng/m^3 in 2016.

- The median concentration decreased each year between 2009 and 2013. Although the median has increased slightly each year since 2013, they are still less than those calculated for the first full-years of sampling at UNVT.

21.4 Additional Risk-Based Screening Evaluations

The following risk-based screening evaluations were conducted to characterize risk related to the air toxics measured at the Vermont monitoring site. Refer to Sections 3.2, 3.4.2.3, and 3.4.2.4 for definitions and explanations regarding the various toxicity factors, time frames, and calculations associated with these risk-based screenings.

21.4.1 Cancer Risk and Noncancer Hazard Approximations

For the pollutants of interest for the Vermont monitoring site, risk was examined by calculating cancer risk and noncancer hazard approximations for each year annual average concentrations could be calculated. These approximations can be used as risk estimates for cancer and noncancer effects attributable to the pollutants of interest. Although the use of these approximations is limited, they may help identify where policy-makers want to shift their air monitoring priorities. Refer to Section 3.4.2.3 for an explanation of how cancer risk and noncancer hazard approximations are calculated and what limitations are associated with them. Annual averages, cancer UREs and/or noncancer RfCs, and cancer risk and noncancer hazard approximations are presented in Table 21-4, where applicable. Cancer risk approximations are presented as probabilities while the noncancer hazard approximations are ratios and thus, unitless values.

Observations from Table 21-4 include the following:

- The annual average concentrations of naphthalene are greater than the annual average concentrations of benzo(a)pyrene.
- Although the cancer risk approximations for naphthalene are an order of magnitude greater than the cancer risk approximations for benzo(a)pyrene, all of these are less than 1 in-a-million.
- The noncancer hazard approximations for naphthalene are both less than 0.01, indicating that no adverse noncancer health effects are expected from this individual pollutant. A noncancer RfC is not available for benzo(a)pyrene.

Table 21-4. Risk Approximations for the Vermont Monitoring Site

Pollutant	Cancer URE ($\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	2015				2016			
			# of Measured Detections vs. # of Samples	Annual Average (ng/m^3)	Risk Approximations		# of Measured Detections vs. # of Samples	Annual Average (ng/m^3)	Risk Approximations	
					Cancer (in-a-million)	Noncancer (HQ)			Cancer (in-a-million)	Noncancer (HQ)
Underhill, Vermont - UNVT										
Benzo(a)pyrene	0.00176	--	19/60	0.02 ± 0.01	0.03	--	22/61	0.03 ± 0.03	0.04	--
Naphthalene	0.000034	0.003	60/60	9.87 ± 1.83	0.34	<0.01	61/61	8.39 ± 1.17	0.29	<0.01

-- = A Cancer URE or Noncancer RfC is not available.

21.4.2 Risk-Based Emissions Assessment

In addition to the risk-based screenings discussed above, this section presents an evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 21-5 presents the 10 pollutants with the highest emissions from the 2014 NEI (version 1) that have cancer toxicity factors. Table 21-5 also presents the 10 pollutants with the highest toxicity-weighted emissions, based on the weighting schema described in Section 3.4.2.4. Lastly, Table 21-5 provides the pollutants of interest with the highest cancer risk approximations (in-a-million) for UNVT, as presented in Table 21-4. Cancer risk approximations for 2015 are presented in green while approximations for 2016 are in white. The emissions, toxicity-weighted emissions, and cancer risk approximations are shown in descending order in Table 21-5. Table 21-6 presents similar information but is limited to those pollutants with noncancer toxicity factors.

Because not all pollutants have both cancer and noncancer toxicity factors, the highest emitted pollutants in the cancer table may be different from the noncancer table, although the actual quantity of emissions is the same. The cancer risk and noncancer hazard approximations based on each site's annual averages are limited to the pollutants of interest identified for each site. In addition, the cancer risk and noncancer hazard approximations are limited to those pollutants with enough data to meet the criteria for annual averages to be calculated. A more in-depth discussion of this analysis is provided in Section 3.4.2.4. Similar to the cancer risk and noncancer hazard approximations provided in Section 21.4.1, this analysis may help policy-makers prioritize their air monitoring activities.

Table 21-5. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Vermont Monitoring Site

Top 10 Total Emissions for Pollutants with Cancer UREs (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Annual Average Concentrations (Site-Specific) [1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Underhill, Vermont (Chittenden County) - UNVT					
Benzene	101.44	POM, Group 3	1.19E-03	Naphthalene	0.34
Formaldehyde	81.09	Formaldehyde	1.05E-03	Naphthalene	0.29
Acetaldehyde	43.22	Benzene	7.91E-04	Benzo(a)pyrene	0.04
Ethylbenzene	25.84	1,3-Butadiene	3.83E-04	Benzo(a)pyrene	0.03
1,3-Butadiene	12.76	Naphthalene	3.31E-04		
Naphthalene	9.73	Arsenic, PM	2.94E-04		
Bis(2-ethylhexyl) phthalate, gas	5.96	POM, Group 2b	2.01E-04		
Dichloromethane	2.87	POM, Group 5a	1.42E-04		
POM, Group 2b	2.28	POM, Group 2d	1.27E-04		
POM, Group 2d	1.45	Hexavalent Chromium, PM	1.09E-04		

[1] Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Table 21-6. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the Vermont Monitoring Site

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Hazard Approximation (HQ)**
Underhill, Vermont (Chittenden County) - UNVT					
Toluene	173.71	Acrolein	689,481.49	Naphthalene	<0.01
Benzene	101.44	Chlorine	15,172.33	Naphthalene	<0.01
Xylenes	94.73	Manganese, PM	12,474.61		
Methanol	81.93	Formaldehyde	8,274.96		
Formaldehyde	81.09	2,4-Toluene diisocyanate	7,296.86		
Hydrochloric acid	44.59	1,3-Butadiene	6,378.93		
Acetaldehyde	43.22	Acetaldehyde	4,802.45		
Hexane	30.90	Arsenic, PM	4,550.92		
Ethylbenzene	25.84	Benzene	3,381.22		
Acrolein	13.79	Naphthalene	3,243.73		

[1] Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Observations from Table 21-5 include the following:

- Benzene, formaldehyde, and acetaldehyde are the highest emitted pollutants with cancer UREs in Chittenden County.

- POM, Group 3 is the pollutant with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) in Chittenden County, followed by formaldehyde and benzene.

- Six of the highest emitted pollutants also have the highest toxicity-weighted emissions for Chittenden County.

- Naphthalene has the fifth highest toxicity-weighted emissions and is the sixth highest emitted pollutant with a cancer URE in Chittenden County.

- Benzo(a)pyrene is part of POM, Group 5a. POM, Group 5a has the eighth highest toxicity-weighted emissions but is not one of the highest emitted in Chittenden County (it ranks 19th).

- POM, Groups 2b and 2d also appear on both-emissions based lists in Table 21-5. POM, Groups 2b includes several PAHs sampled for with Method TO-13A, although none of these failed screens for UNVT. POM, Group 3, which has the highest toxicity-weighted emissions (of the pollutants with cancer UREs) in Chittenden County, does not include any of the PAHs sampled for at UNVT.

Observations from Table 21-6 include the following:

- Toluene, benzene, and xylenes are the highest emitted pollutants with noncancer RfCs in Chittenden County.

- Acrolein is the pollutant with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) for Chittenden County, followed by chlorine and manganese (PM).

- Four of the highest emitted pollutants for Chittenden County also have the highest toxicity-weighted emissions.

- Naphthalene has the tenth highest toxicity-weighted emissions but is not one of the highest emitted in Chittenden County (it ranks 13th). As discussed in the previous section, benzo(a)pyrene, which is part of POM, Group 5a, does not have a noncancer RfC.

21.5 Summary of the 2015-2016 Monitoring Data for the Vermont Monitoring Site

Results from several of the data analyses described in this section include the following:

- ❖ *PAHs were sampled for at UNVT in 2015 and 2016.*

- ❖ *Naphthalene and benzo(a)pyrene were identified as pollutants of interest for UNVT.*

- *UNVT's annual average concentrations of naphthalene are the lowest annual averages of this pollutant among NMP sites sampling PAHs. This is also true for benzo(a)pyrene.*

- *Concentrations of naphthalene have a decreasing trend at UNVT.*

22.0 Site in Virginia

This section summarizes those data from samples collected at the NATTS site in Virginia and generated by ERG, EPA's contract laboratory for the NMP, over the 2015 and 2016 monitoring efforts. This section also examines the spatial and temporal characteristics of the ambient monitoring concentrations and reviews them through the context of risk. Readers are encouraged to refer to Sections 1 through 4 for detailed discussions and definitions regarding the various data analyses presented below.

Data generated by sources other than ERG, EPA's contract laboratory for the NMP, are not included in the data analyses contained in this report.

22.1 Site Characterization

This section characterizes the Virginia monitoring site by providing a description of the nearby area surrounding the monitoring site; plotting emissions sources surrounding the monitoring site; and presenting traffic data and other characterizing information for the site. This information is provided to give the reader insight regarding factors that may influence the air quality near the site and assist in the interpretation of the ambient monitoring measurements.

The RIVA monitoring site is located just outside the Richmond, Virginia city limits in East Highland Park. Figure 22-1 presents a composite satellite image retrieved from ArcGIS Explorer showing the monitoring site and its immediate surroundings. Figure 22-2 identifies nearby point source emissions locations by source category, as reported in the 2014 NEI for point sources, version 1. Note that only sources within 10 miles of the site are included in the facility counts provided in Figure 22-2. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have a direct effect on the air quality at the monitoring site. Further, this boundary provides both the proximity of emissions sources to the monitoring site as well as the quantity of such sources within a given distance of the site. Sources outside the 10-mile boundary are still visible on the map for reference but have been grayed out to emphasize emissions sources within the boundary. Table 22-1 provides supplemental geographical information such as land use, location setting, and locational coordinates. Each figure and table is discussed in detail in the paragraphs that follow.

Figure 22-1. East Highland Park, Virginia (RIVA) Monitoring Site

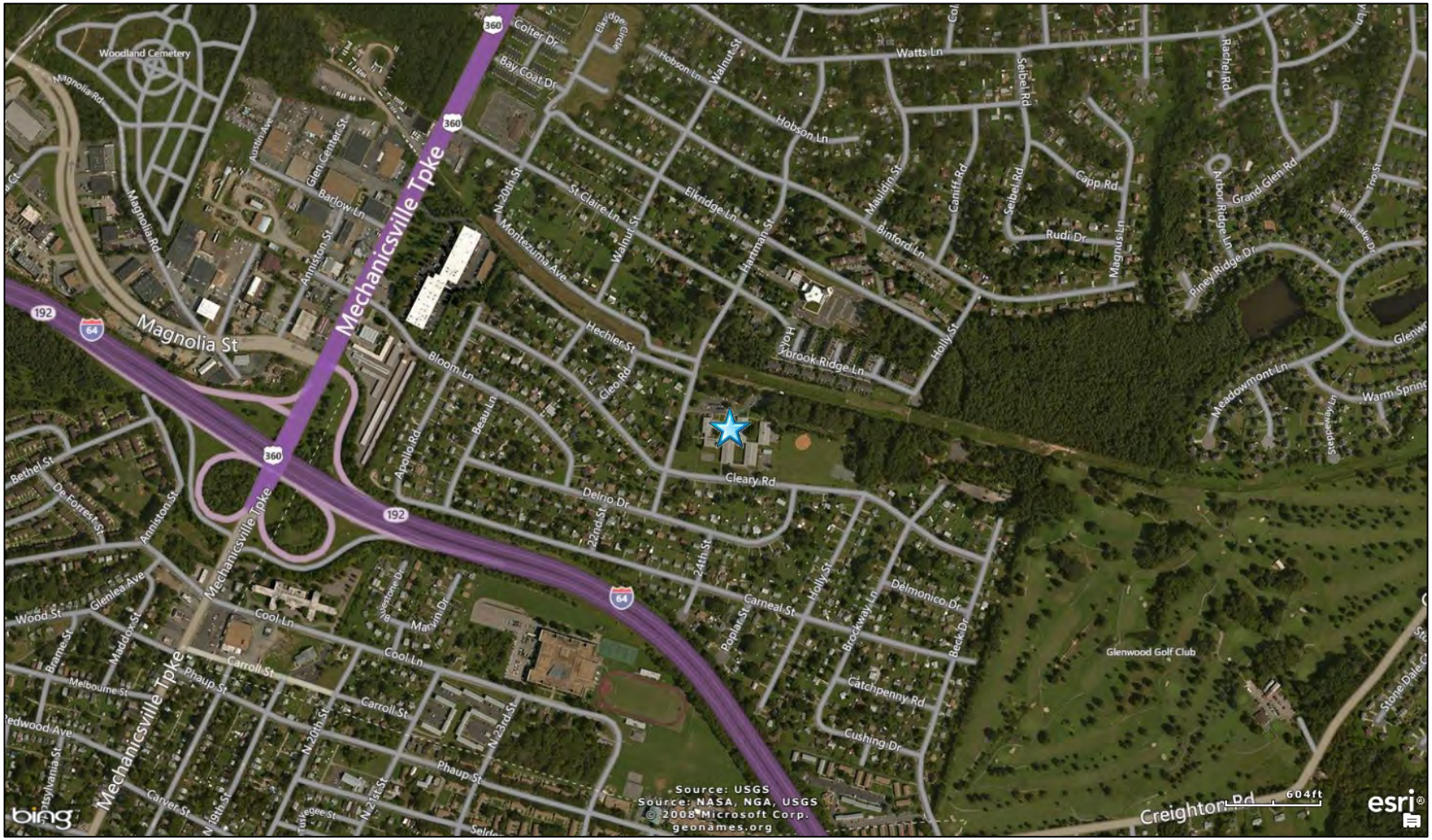


Figure 22-2. NEI Point Sources Located Within 10 Miles of RIVA

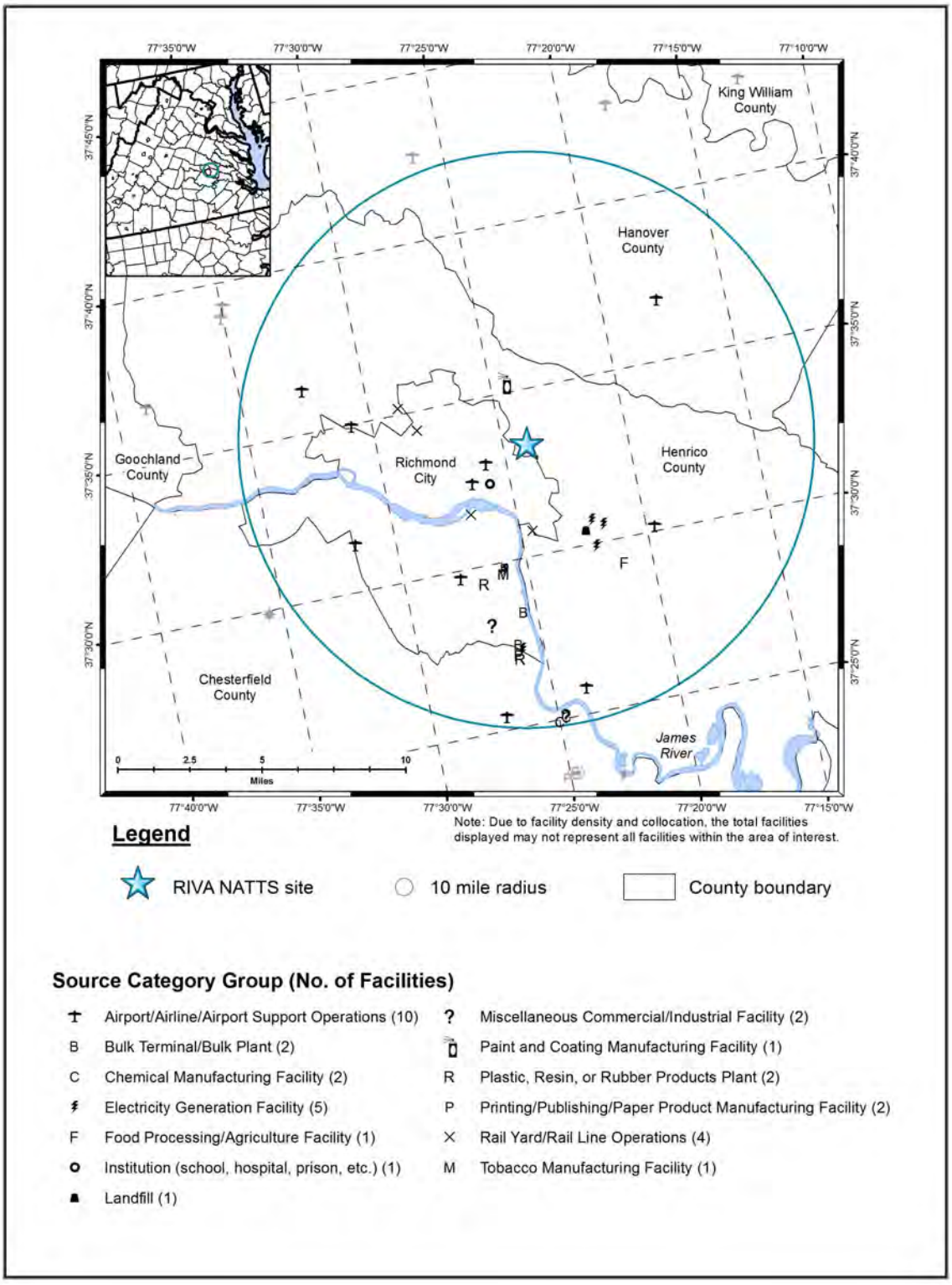


Table 22-1. Geographical Information for the Virginia Monitoring Site

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Annual Average Daily Traffic[1]	Intersection Used for Traffic Data
RIVA	51-087-0014	East Highland Park	Henrico	Richmond, VA	37.556520, -77.400270	Residential	Suburban	80,000	I-64 at Mechanicsville Turnpike/US-360

[1]AADT reflects 2016 data (VA DOT, 2016)
BOLD ITALICS = EPA-designated NATTS Site

The RIVA monitoring site is located just northeast of the capital city of Richmond, in east-central Virginia. The site is located at the MathScience Innovation Center in a residential area about one-quarter mile from I-64. The I-64 interchange with Mechanicsville Turnpike (US-360) is one-half mile west of the site, as shown in Figure 22-1. Beyond the residential areas surrounding the school property are a golf course to the southeast, a high school to the south (on the south side of I-64), and commercial areas to the west.

As Figure 22-2 shows, RIVA is located near several point sources, most of which are located on the southern half of the 10-mile boundary and within the city of Richmond. The source categories with the greatest number of emissions sources within 10 miles of RIVA are the airport source category, which includes airports and related operations as well as small runways and heliports, such as those associated with hospitals or television stations; facilities generating electricity via combustion; and rail yard and rail line operations. The source closest to RIVA is a heliport at the Medical College of Virginia.

In addition to providing city, county, CBSA, and land use/location setting information, Table 22-1 also contains traffic volume information for the site as well as the location for which the traffic volume was obtained. This information is provided because emissions from motor vehicles can significantly affect concentrations measured at a given monitoring site. The traffic volume experienced near RIVA is 80,000, which is in the top third of the range compared to other NMP monitoring sites, ranking 15th. The traffic volume provided is for I-64 at US-360 (Mechanicsville Turnpike).

22.2 Pollutants of Interest

The risk-based screening process described in Section 3.2 was performed for each monitoring site to identify site-specific "pollutants of interest," which allows analysts and readers to focus on a subset of pollutants through the context of risk. Each pollutant's preprocessed daily measurement was compared to its associated risk screening value. If the concentration was greater than the risk screening value, then the concentration "failed the screen." The site-specific results of this risk-based screening process are presented in Table 22-2 and incorporate measurements from both 2015 and 2016. Pollutants of interest are those for which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens and are shaded in gray in Table 22-2. It is important to note which pollutants were sampled for at each site when reviewing the results of this analysis. PAHs and hexavalent

chromium were sampled for at RIVA, although hexavalent chromium sampling was discontinued at the end of June 2016.

Table 22-2. 2015-2016 Risk-Based Screening Results for the Virginia Monitoring Site

Pollutant	Screening Value ($\mu g/m^3$)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
East Highland Park, Virginia - RIVA						
Naphthalene	0.029	105	116	90.52	99.06	99.06
Hexavalent Chromium	0.000083	1	59	1.69	0.94	100.00
Total		106	175	60.57	100.00	

Observations from Table 22-2 include the following:

- Concentrations naphthalene and hexavalent chromium failed at least one screen for RIVA.
- Nearly 61 percent of concentrations of these two pollutants failed screens, although concentrations of naphthalene account for all but one of the 106 failed screens for RIVA. Thus, naphthalene is RIVA's only pollutant of interest.

For each of the data analyses described in the remaining sections, the focus is on the site-specific pollutants of interest identified via the risk-based screening process, as described in Section 3.4.2.

22.3 Concentrations

This section presents various concentration averages used to characterize air toxics concentration levels at the Virginia monitoring site. Where applicable, the following calculations and data analyses were performed for each of the site-specific pollutants of interest:

- Time period-based concentration averages (quarterly and annual) are provided for each monitoring site for each year of sampling.
- The range of measurements and annual concentration averages are presented graphically for each site to illustrate how the site's concentrations compare to the program-level averages, as presented in Section 4.1.
- Concentration averages and other statistical metrics for 2015, 2016, and from previous years of monitoring are presented in order to characterize concentration trends at each site.

Each data analysis is performed where the applicable criteria are met (as specified in the appropriate sections discussed below) and is limited to the site-specific pollutants of interest. However, site-specific statistical summaries for all pollutants sampled for at RIVA are provided in Appendices N and P.

22.3.1 2015 and 2016 Concentration Averages

Quarterly and annual concentration averages for 2015 and 2016 were calculated for the pollutants of interest for RIVA, as described in Section 3.1. The *quarterly average concentration* of a particular pollutant is simply the average concentration of the preprocessed daily measurements over a given calendar quarter. Quarterly average concentrations include the substitution of zeros for all non-detects. A site must have a minimum of 75 percent valid samples compared to the total number of samples possible within a given calendar quarter for a quarterly average to be calculated. An *annual average concentration* includes all measured detections and substituted zeros for non-detects for an entire year of sampling. Annual averages were calculated for pollutants where three valid quarterly averages could be calculated for a given year and where method completeness was greater than or equal to 85 percent, as presented in Section 2.4. Quarterly and annual average concentrations for the pollutant of interest for the Virginia monitoring site are presented in Table 22-3, where applicable. Note that if a pollutant was not detected in a given calendar quarter, the quarterly average simply reflects "0" because only zeros substituted for non-detects were factored into the quarterly average concentration.

Observations for RIVA from Table 22-3 include the following:

- Naphthalene was detected in every valid PAH sample collected at RIVA in 2015 and 2016. Concentrations of naphthalene measured at RIVA range from 11.0 ng/m^3 to 183 ng/m^3.

- The annual average concentration of naphthalene for 2015 is similar to the annual average concentration for 2016.

- The quarterly average concentrations range from 56.64 ± 18.04 ng/m^3 (second quarter 2016) to 86.02 ± 27.24 ng/m^3 (fourth quarter 2015). At least one naphthalene concentration greater than 100 ng/m^3 was measured during each calendar quarter, with the most measured during the fourth quarter of each year (between one and three were measured during the first, second, or third quarters each year, compared to five measured during the fourth quarter of 2015 and six during the fourth quarter of 2016).

Table 22-3. Quarterly and Annual Average Concentrations of the Pollutants of Interest for the Virginia Monitoring Site

Pollutant	2015						2016					
	# of Detects/ # >MDL/ # Samples	Q1 Avg (ng/m^3)	Q2 Avg (ng/m^3)	Q3 Avg (ng/m^3)	Q4 Avg (ng/m^3)	Annual Average (ng/m^3)	# of Detects/ # >MDL/ # Samples	Q1 Avg (ng/m^3)	Q2 Avg (ng/m^3)	Q3 Avg (ng/m^3)	Q4 Avg (ng/m^3)	Annual Average (ng/m^3)
East Highland Park, Virginia - RIVA												
Naphthalene	56/56/56	64.21 ± 12.74	70.04 ± 15.26	64.28 ± 17.02	86.02 ± 27.24	71.24 ± 9.12	60/60/60	67.57 ± 22.93	56.64 ± 18.04	63.71 ± 15.81	81.61 ± 24.97	67.57 ± 10.11

22.3.2 Concentration Comparison

In order to better illustrate how each site's annual average concentrations compare to the program-level averages, a site-specific box plot was created for each of the site-specific pollutants of interest, where applicable. Thus, a box plot was created for the pollutant listed in Table 22-3 for RIVA. Figure 22-3 overlays the site's minimum, annual average, and maximum concentrations for each year onto the program-level minimum, first quartile, median, average, third quartile, and maximum concentrations, as described in Section 3.4.2.1, and are discussed below. If an annual average concentration could not be calculated, the range of concentrations are still provided in the figures that follow.

Figure 22-3. Program vs. Site-Specific Average Naphthalene Concentrations

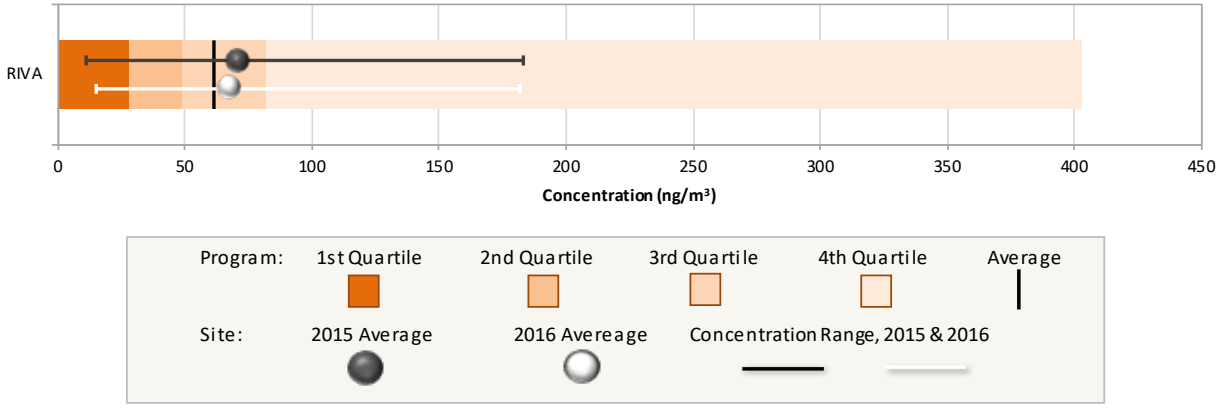


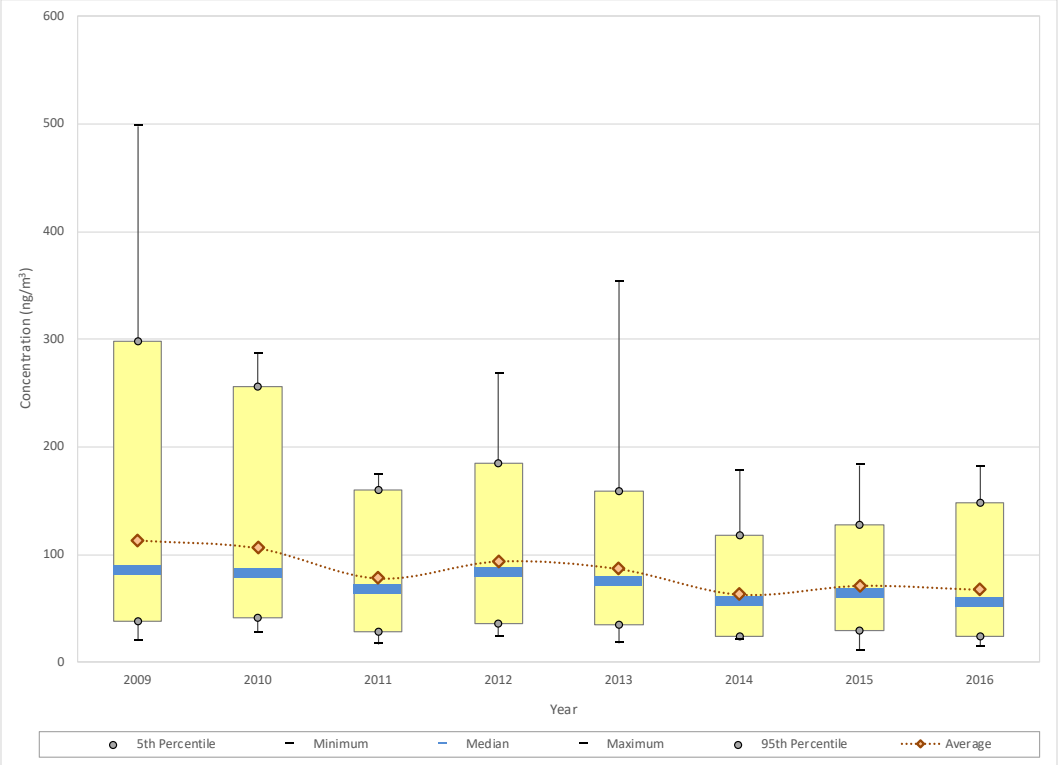
Figure 22-3 presents the box plot for naphthalene for RIVA and shows the following:

- The range of naphthalene concentrations measured each year at RIVA are similar to each other.
- The maximum naphthalene concentrations measured at RIVA each year (183 ng/m^3 for 2015 and 182 ng/m^3 for 2016) are considerably less than the program-level maximum concentration (403 ng/m^3).
- There were no non-detects of naphthalene measured at RIVA, or across the program (although difficult to discern in Figure 22-3).
- The annual average concentrations of naphthalene for RIVA are both just greater than the program-level average concentration (61.23 ng/m^3).

22.3.3 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the pollutants of interest for 5 consecutive years or longer, as described in Section 3.4.2.2. RIVA began sampling PAHs under the NMP in October 2008. Thus, Figure 22-4 presents the 1-year statistical metrics for the pollutant of interest for RIVA. The statistical metrics presented for assessing trends include the substitution of zeros for non-detects. If sampling began mid-year, a minimum of 6 months of sampling is required for inclusion in the trends analysis; in these cases, a 1-year average concentration is not provided, although the range and percentiles are still presented.

Figure 22-4. Yearly Statistical Metrics for Naphthalene Concentrations Measured at RIVA



Observations from Figure 22-4 for naphthalene concentrations measured at RIVA include the following:

- RIVA began sampling PAHs under the NMP in October 2008. Because less than 6 months of data are available for 2008, Figure 22-4 begins with 2009.
- Three naphthalene concentrations greater than 400 ng/m^3 were measured at RIVA during the fall of 2009. The next highest concentration was measured in 2013 (354 ng/m^3) and is the only other concentration greater than 300 ng/m^3 measured at RIVA.

- Most of the statistical parameters exhibit a decreasing trend through 2011, with the most significant change occurring between 2010 and 2011. All of the statistical parameters exhibit an increase for 2012 before decreasing slightly for 2013 (with the exception of the maximum concentration) and again for 2014. The 1-year average concentration is at a minimum for 2014.

- Relatively little change is shown in the range of concentrations measured between 2014 and 2016. During this 3-year period, the 1-year average concentration varied by less than 10 ng/m^3 and the median concentration varied by less than 7 ng/m^3.

22.4 Additional Risk-Based Screening Evaluations

The following risk-based screening evaluations were conducted to characterize risk related to the air toxics measured at the RIVA monitoring site. Refer to Sections 3.2, 3.4.2.3, and 3.4.2.4 for definitions and explanations regarding the various toxicity factors, time frames, and calculations associated with these risk-based screenings.

22.4.1 Cancer Risk and Noncancer Hazard Approximations

For the pollutants of interest for RIVA, risk was examined by calculating cancer risk and noncancer hazard approximations for each year annual average concentrations could be calculated. These approximations can be used as risk estimates for cancer and noncancer effects attributable to the pollutants of interest. Although the use of these approximations is limited, they may help identify where policy-makers want to shift their air monitoring priorities. Refer to Section 3.4.2.3 for an explanation of how cancer risk and noncancer hazard approximations are calculated and what limitations are associated with them. Annual averages, cancer UREs and/or noncancer RfCs, and cancer risk and noncancer hazard approximations are presented in Table 22-4, where applicable. Cancer risk approximations are presented as probabilities while the noncancer hazard approximations are ratios and thus, unitless values.

Table 22-4. Risk Approximations for the Virginia Monitoring Site

Pollutant	Cancer URE $(\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	2015				2016			
			# of Measured Detections vs. # of Samples	Annual Average (ng/m^3)	Risk Approximations		# of Measured Detections vs. # of Samples	Annual Average (ng/m^3)	Risk Approximations	
					Cancer (in-a-million)	Noncancer (HQ)			Cancer (in-a-million)	Noncancer (HQ)
East Highland Park, Virginia - RIVA										
Naphthalene	0.000034	0.003	56/56	71.24 ± 9.12	2.42	0.02	60/60	67.57 ± 10.11	2.30	0.02

Observations for RIVA from Table 22-4 include the following:

- The annual average concentrations of naphthalene are 71.24 ± 9.12 ng/m^3 for 2015 and 67.57 ± 10.11 ng/m^3 for 2016.
- The cancer risk approximations for naphthalene, based on RIVA's annual average concentrations, are 2.42 in-a-million for 2015 and 2.30 in-a-million for 2016.
- The noncancer hazard approximations for naphthalene are both considerably less than 1.0 (0.02 for both years), indicating that no adverse noncancer health effects are expected from this individual pollutant.

22.4.2 Risk-Based Emissions Assessment

In addition to the risk-based screening discussed above, this section presents an evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 22-5 presents the 10 pollutants with the highest emissions from the 2014 NEI (version 1) that have cancer toxicity factors. Table 22-5 also presents the 10 pollutants with the highest toxicity-weighted emissions, based on the weighting schema described in Section 3.4.2.4. Lastly, Table 22-5 provides the pollutants of interest with the highest cancer risk approximations (in-a-million) for RIVA, as presented in Table 22-4. Cancer risk approximations for 2015 are presented in green while approximations for 2016 are in white. The emissions, toxicity-weighted emissions, and cancer risk approximations are shown in descending order in Table 22-5. Table 22-6 presents similar information, but is limited to those pollutants with noncancer toxicity factors.

Because not all pollutants have both cancer and noncancer toxicity factors, the highest emitted pollutants in the cancer table may be different from the noncancer table, although the actual quantity of emissions is the same. The cancer risk and noncancer hazard approximations based on each site's annual averages are limited to the pollutants of interest identified for each site. In addition, the cancer risk and noncancer hazard approximations are limited to those pollutants with enough data to meet the criteria for annual average concentrations to be calculated. A more in-depth discussion of this analysis is provided in Section 3.4.2.4. Similar to the cancer risk and noncancer hazard approximations provided in Section 22.4.1, this analysis may help policy-makers prioritize their air monitoring activities.

Table 22-5. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Virginia Monitoring Site

Top 10 Total Emissions for Pollutants with Cancer UREs (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
East Highland Park, Virginia (Henrico County) - RIVA					
Benzene	90.56	Formaldehyde	1.13E-03	Naphthalene	2.42
Formaldehyde	86.58	Benzene	7.06E-04	Naphthalene	2.30
Ethylbenzene	51.26	1,3-Butadiene	4.48E-04		
Acetaldehyde	47.24	Naphthalene	2.61E-04		
1,3-Butadiene	14.92	POM, Group 2b	1.55E-04		
Naphthalene	7.69	Ethylbenzene	1.28E-04		
POM, Group 2b	1.76	POM, Group 2d	1.11E-04		
POM, Group 2d	1.26	Acetaldehyde	1.04E-04		
Trichloroethylene	0.49	POM, Group 5a	9.23E-05		
Dichloromethane	0.44	Arsenic, PM	4.75E-05		

[1] Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Table 22-6. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the Virginia Monitoring Site

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Hazard Approximation (HQ)**
East Highland Park, Virginia (Henrico County) - RIVA					
Ethylene glycol	383.19	Acrolein	332,228.50	Naphthalene	0.02
Toluene	303.05	Formaldehyde	8,834.97	Naphthalene	0.02
Xylenes	178.93	1,3-Butadiene	7,459.46		
Methanol	146.28	Acetaldehyde	5,248.37		
Hexane	114.66	Benzene	3,018.68		
Benzene	90.56	Naphthalene	2,562.65		
Formaldehyde	86.58	Xylenes	1,789.35		
Ethylbenzene	51.26	Ethylene glycol	957.97		
Acetaldehyde	47.24	Glycol ethers, gas	798.69		
Glycol ethers, gas	15.98	Cyanide Compounds, gas	784.97		

[1] Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Observations from Table 22-5 include the following:

- Benzene, formaldehyde, and ethylbenzene are the highest emitted pollutants with cancer UREs in Henrico County.

- The pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) are formaldehyde, benzene, and 1,3-butadiene.

- Eight of the highest emitted pollutants also have the highest toxicity-weighted emissions for Henrico County.

- Naphthalene, the only pollutant of interest for RIVA, has the sixth highest emissions and the fourth highest toxicity-weighted emissions for Henrico County.

- Several POM Groups appear in Table 22-5. POM, Group 2b is the seventh highest emitted "pollutant" in Henrico County and ranks fifth for toxicity-weighted emissions. POM, Group 2b includes several PAHs sampled for at RIVA, including fluorene, perylene, and acenaphthene. None of the PAHs sampled for at RIVA included in POM, Group 2b failed screens. POM, Group 2d also appears on both emissions-based lists for Henrico County but does not include any PAHs sampled for at RIVA. POM, Group 5a includes benzo(a)pyrene and ranks ninth for toxicity-weighted emissions but is not among the highest emitted. Concentrations of benzo(a)pyrene measured at RIVA did not fail screens.

Observations from Table 22-6 include the following:

- Ethylene glycol, toluene, and xylenes are the highest emitted pollutants with noncancer RfCs in Henrico County.

- The pollutants with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) are acrolein, formaldehyde, and 1,3-butadiene.

- Six of the highest emitted pollutants in Henrico County also have the highest toxicity-weighted emissions.

- Naphthalene has the sixth highest toxicity-weighted emissions for Henrico County but is not among the highest emitted pollutants with a noncancer toxicity factor in Henrico County (it ranks 12th).

22.5 Summary of the 2015-2016 Monitoring Data for RIVA

Results from several of the data analyses described in this section include the following:

- ❖ *Concentrations of naphthalene and hexavalent chromium failed at least one screen, although naphthalene was the only pollutant identified as a pollutant of interest for RIVA.*

- ❖ *The range of naphthalene concentrations measured at RIVA varied little across the two years of sampling.*

- *Concentrations of naphthalene have decreased at RIVA since the onset of PAH sampling at this site, although concentrations have leveled off over the last few years.*

23.0 Site in Washington

This section summarizes those data from samples collected at the NATTS site in Washington and generated by ERG, EPA's contract laboratory for the NMP, over the 2015 and 2016 monitoring efforts. This section also examines the spatial and temporal characteristics of the ambient monitoring concentrations and reviews them through the context of risk. Readers are encouraged to refer to Sections 1 through 4 for detailed discussions and definitions regarding the various data analyses presented below.

Data generated by sources other than ERG, EPA's contract laboratory for the NMP, are not included in the data analyses contained in this report.

23.1 Site Characterization

This section characterizes the Washington monitoring site by providing a description of the nearby area surrounding the monitoring site; plotting emissions sources surrounding the monitoring site; and presenting traffic data and other characterizing information for the site. This information is provided to give the reader insight regarding factors that may influence the air quality near the site and assist in the interpretation of the ambient measurements.

The NATTS site in Washington is located in Seattle. Figure 23-1 presents a composite satellite image retrieved from ArcGIS Explorer showing the monitoring site and its immediate surroundings. Figure 23-2 identifies nearby point source emissions locations by source category, as reported in the 2014 NEI for point sources, version 1. Note that only sources within 10 miles of the site are included in the facility counts provided in Figure 23-2. A 10-mile boundary was chosen to give the reader an indication of which emissions sources and emissions source categories could potentially have a direct effect on the air quality at the monitoring site. Further, this boundary provides both the proximity of emissions sources to the monitoring site as well as the quantity of such sources within a given distance of the site. Sources outside the 10-mile boundary are still visible on the map for reference but have been grayed out to emphasize emissions sources within the boundary. Table 23-1 provides supplemental geographical information such as land use, location setting, and locational coordinates. Each figure and table is discussed in detail in the paragraphs that follow.

Figure 23-1. Seattle, Washington (SEWA) Monitoring Site

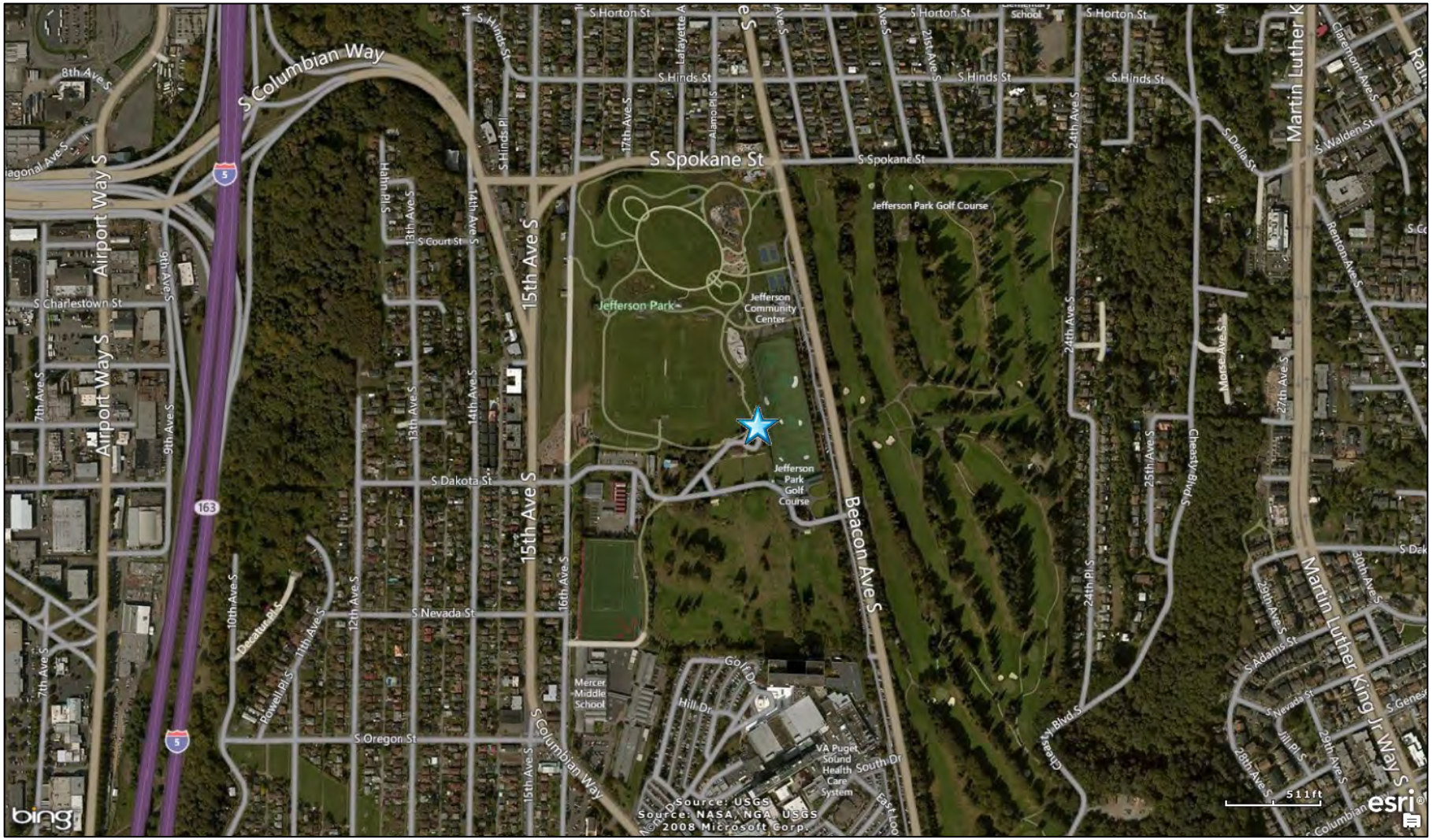


Figure 23-2. NEI Point Sources Located Within 10 Miles of SEWA

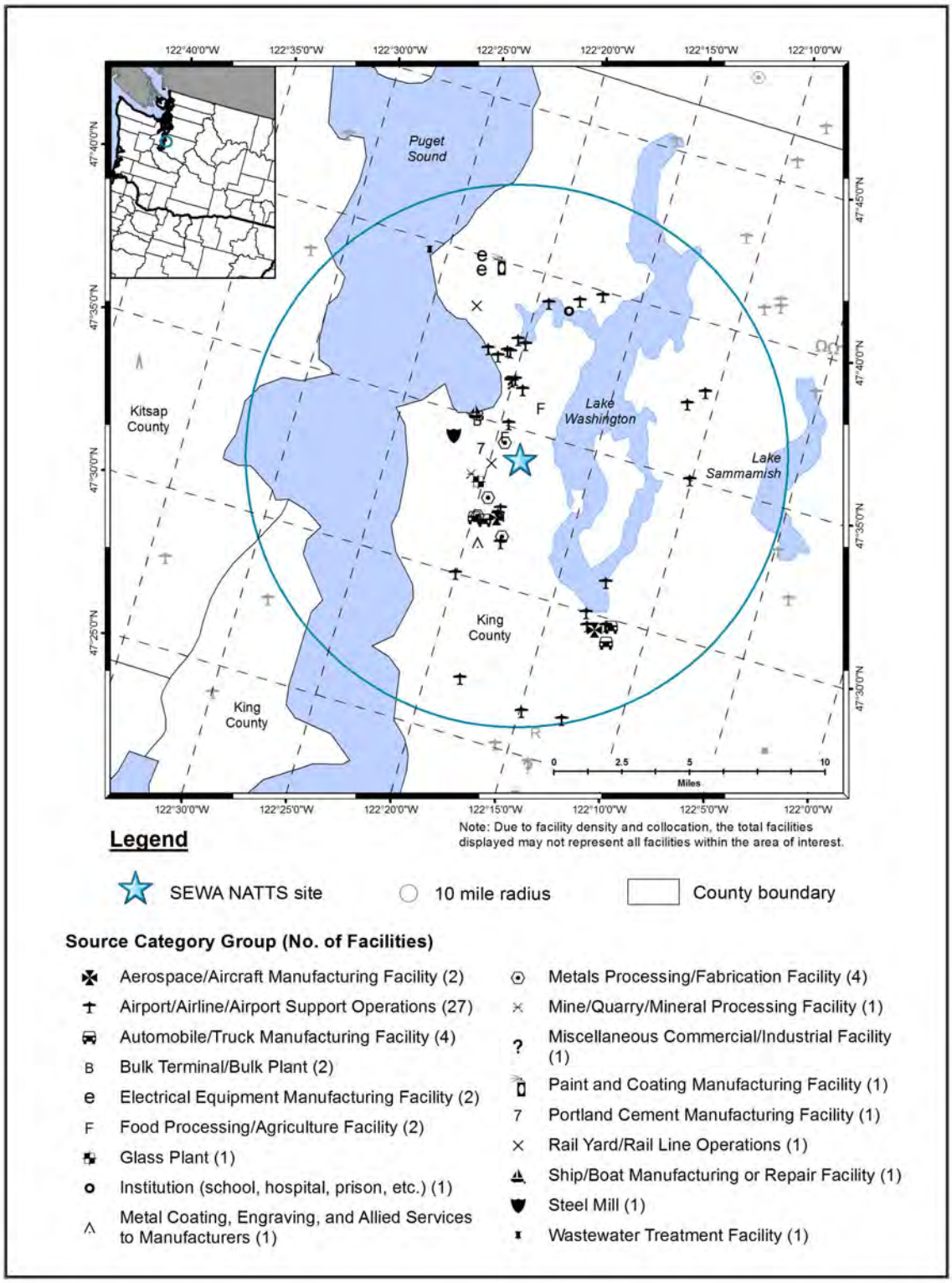


Table 23-1. Geographical Information for the Washington Monitoring Site

Site Code	AQS Code	Location	County	Micro- or Metropolitan Statistical Area	Latitude and Longitude	Land Use	Location Setting	Annual Average Daily Traffic[1]	Intersection Used for Traffic Data
SEWA	53-033-0080	Seattle	King	Seattle-Tacoma-Bellevue, WA	47.568236, -122.308628	Residential	Urban/City Center	186,000	I-5 S at Spokane St Viaduct

[1]AADT reflects 2015 data (WS DOT, 2015)
BOLD ITALICS = EPA-designated NATTS Site

The SEWA monitoring site is located in Seattle, at the southeast corner of the Beacon Hill Reservoir. The reservoir is covered and the entire area is part of Jefferson Park (Seattle, 2018). The reservoir and park are separated from the Jefferson Park Golf Course to the east by Beacon Avenue, as shown in Figure 23-1. A middle school and a hospital can be seen to the south of the site in the bottom-center portion of Figure 23-1. The site is surrounded by residential neighborhoods to the west, north, and east. Interstate-5, which runs north-south through Seattle, is just over one-half mile to the west of SEWA and intersects with I-90 a couple of miles farther north of the site. The area to the west of I-5 is highly industrial while the area to the east is primarily residential. Although the emissions sources within 10 miles of the site are involved in a variety of industries, the airport source category, which includes airports and related operations as well as small runways and heliports, such as those associated with hospitals or television stations, has the greatest number of sources. The closest point sources to SEWA are a metals processing and fabrication facility, a food processing facility, and a rail yard/rail line operation, as shown in Figure 23-2.

In addition to providing city, county, CBSA, and land use/location setting information, Table 23-1 also contains traffic volume information for SEWA as well as the location for which the traffic volume was obtained. This information is provided because emissions from motor vehicles can significantly affect concentrations measured at a given monitoring site. The traffic volume experienced near SEWA is 186,000, which is the fourth highest compared to traffic volumes near other NMP monitoring sites. The traffic estimate provided is for I-5 at the Spokane Street Viaduct.

23.2 Pollutants of Interest

The risk-based screening process described in Section 3.2 was performed for each site to identify site-specific "pollutants of interest," which allows analysts and readers to focus on a subset of pollutants through the context of risk. Each pollutant's preprocessed daily measurement was compared to its associated risk screening value. If the concentration was greater than the risk screening value, then the concentration "failed the screen." The site-specific results of this risk-based screening process are presented in Table 23-2 and incorporate measurements from both 2015 and 2016. Pollutants of interest are those for which the individual pollutant's total failed screens contribute to the top 95 percent of the site's total failed screens and are shaded in gray in Table 23-2. It is important to note which pollutants were sampled for at the site when reviewing

the results of this analysis. PM_{10} metals, VOCs, PAHs, and carbonyl compounds were sampled for at SEWA.

Table 23-2. 2015-2016 Risk-Based Screening Results for the Washington Monitoring Site

Pollutant	Screening Value ($\mu g/m^3$)	# of Failed Screens	# of Measured Detections	% of Screens Failed	% of Total Failures	Cumulative % Contribution
Seattle, Washington - SEWA						
Formaldehyde	0.077	119	120	99.17	14.15	14.15
Benzene	0.13	118	118	100.00	14.03	28.18
Carbon Tetrachloride	0.17	118	118	100.00	14.03	42.21
1,2-Dichloroethane	0.038	108	110	98.18	12.84	55.05
Arsenic (PM_{10})	0.00023	101	116	87.07	12.01	67.06
1,3-Butadiene	0.03	99	113	87.61	11.77	78.83
Naphthalene	0.029	79	118	66.95	9.39	88.23
Acetaldehyde	0.45	77	120	64.17	9.16	97.38
Nickel (PM_{10})	0.0021	8	116	6.90	0.95	98.34
Ethylbenzene	0.4	7	118	5.93	0.83	99.17
Cadmium (PM_{10})	0.00056	3	116	2.59	0.36	99.52
Acenaphthene	0.011	1	110	0.91	0.12	99.64
p-Dichlorobenzene	0.091	1	7	14.29	0.12	99.76
Fluorene	0.011	1	92	1.09	0.12	99.88
Manganese (PM_{10})	0.03	1	116	0.86	0.12	100.00
Total		841	1,608	52.30		

Observations from Table 23-2 for SEWA include the following:

- Concentrations of 15 pollutants failed at least one screen for SEWA; 52 percent of concentrations for these 15 pollutants were greater than their associated risk screening value (or failed screens).

- Concentrations of eight pollutants contributed to 95 percent of failed screens for SEWA and therefore were identified as pollutants of interest for the site. These eight include two carbonyl compounds, four VOCs, one PM_{10} metal, and one PAH.

- Benzene and carbon tetrachloride were detected in every valid VOC sample collected at SEWA and failed 100 percent of screens.

For each of the data analyses described in the remaining sections, the focus is on the site-specific pollutants of interest identified via the risk-based screening process, as described in Section 3.4.2.

23.3 Concentrations

This section presents various concentration averages used to characterize air toxics concentration levels at the Washington monitoring site. Where applicable, the following calculations and data analyses were performed for each of the site-specific pollutants of interest:

- Time period-based concentration averages (quarterly and annual) are provided for each monitoring site for each year of sampling.
- The range of measurements and annual concentration averages are presented graphically for each site to illustrate how the site's concentrations compare to the program-level averages, as presented in Section 4.1.
- Concentration averages and other statistical metrics for 2015, 2016, and from previous years of monitoring are presented in order to characterize concentration trends at each site.

Each data analysis is performed where the applicable criteria are met (as specified in the appropriate sections discussed below) and is limited to the site-specific pollutants of interest. However, site-specific statistical summaries for all pollutants sampled for at SEWA are provided in Appendices J, M, N, and O.

23.3.1 2015 and 2016 Concentration Averages

Quarterly and annual concentration averages for 2015 and 2016 were calculated for the pollutants of interest for SEWA, as described in Section 3.1. The *quarterly average concentration* of a particular pollutant is simply the average concentration of the preprocessed daily measurements over a given calendar quarter. Quarterly average concentrations include the substitution of zeros for all non-detects. A site must have a minimum of 75 percent valid samples compared to the total number of samples possible within a given calendar quarter for a quarterly average to be calculated. An *annual average concentration* includes all measured detections and substituted zeros for non-detects for an entire year of sampling. Annual averages were calculated for pollutants where three valid quarterly averages could be calculated for a given year and where method completeness was greater than or equal to 85 percent, as presented in Section 2.4. Quarterly and annual average concentrations for the pollutants of interest for the Washington monitoring site are presented in Table 23-3, where applicable. Note that concentrations of the PAHs and PM_{10} metals are presented in ng/m^3 for ease of viewing. Also, note that if a pollutant was not detected in a given calendar quarter, the quarterly average simply reflects "0" because only zeros substituted for non-detects were factored into the quarterly average concentration.

Table 23-3. Quarterly and Annual Average Concentrations of the Pollutants of Interest for the Washington Monitoring Site

Pollutant	2015						2016					
	# of Detects/ # >MDL/ # Samples	Q1 Avg (µg/m^3)	Q2 Avg (µg/m^3)	Q3 Avg (µg/m^3)	Q4 Avg (µg/m^3)	Annual Average (µg/m^3)	# of Detects/ # >MDL/ # Samples	Q1 Avg (µg/m^3)	Q2 Avg (µg/m^3)	Q3 Avg (µg/m^3)	Q4 Avg (µg/m^3)	Annual Average (µg/m^3)
Seattle, Washington - SEWA												
Acetaldehyde	59/59/59	0.78 ± 0.22	0.65 ± 0.20	0.85 ± 0.21	0.54 ± 0.17	0.71 ± 0.10	61/61/61	0.48 ± 0.22	0.54 ± 0.11	0.83 ± 0.19	0.69 ± 0.25	0.64 ± 0.10
Benzene	57/57/57	0.75 ± 0.22	0.36 ± 0.06	0.37 ± 0.09	0.60 ± 0.11	0.52 ± 0.07	61/61/61	0.70 ± 0.17	0.32 ± 0.04	0.27 ± 0.05	0.58 ± 0.13	0.47 ± 0.07
1,3-Butadiene	55/46/57	0.10 ± 0.04	0.04 ± 0.01	0.04 ± 0.01	0.07 ± 0.02	0.06 ± 0.01	58/21/61	0.09 ± 0.03	0.04 ± 0.01	0.03 ± 0.01	0.06 ± 0.03	0.06 ± 0.01
Carbon Tetrachloride	57/57/57	0.67 ± 0.03	0.66 ± 0.03	0.70 ± 0.04	0.66 ± 0.03	0.67 ± 0.02	61/61/61	0.68 ± 0.04	0.74 ± 0.03	0.67 ± 0.05	0.70 ± 0.04	0.70 ± 0.02
1,2-Dichloroethane	56/45/57	0.08 ± 0.01	0.07 ± <0.01	0.04 ± 0.01	0.06 ± <0.01	0.06 ± <0.01	54/44/61	0.07 ± <0.01	0.07 ± 0.01	0.03 ± 0.01	0.06 ± <0.01	0.06 ± 0.01
Formaldehyde	59/59/59	0.68 ± 0.20	0.51 ± 0.13	0.72 ± 0.23	0.48 ± 0.18	0.60 ± 0.09	61/61/61	0.37 ± 0.15	0.48 ± 0.10	0.86 ± 0.19	0.90 ± 0.25	0.66 ± 0.10
Arsenic (PM_{10})[a]	58/57/58	1.27 ± 0.44	0.52 ± 0.14	0.65 ± 0.36	0.67 ± 0.23	0.77 ± 0.16	58/58/58	0.74 ± 0.34	0.64 ± 0.13	0.45 ± 0.16	0.55 ± 0.21	0.60 ± 0.12
Naphthalene[a]	57/57/57	47.03 ± 13.61	37.71 ± 9.36	43.42 ± 11.11	44.87 ± 11.97	43.30 ± 5.54	61/61/61	50.64 ± 14.14	30.70 ± 5.43	42.72 ± 10.59	44.96 ± 15.34	42.59 ± 6.03

[a] Average concentrations provided for the pollutants below the blue line are presented in ng/m^3 for ease of viewing.

Observations from Table 23-3 include the following:

- Similar to previous years, the annual average concentrations for all of SEWA's pollutants of interest are less than 1.0 µg/m^3. The pollutants with the highest annual average concentrations are acetaldehyde, carbon tetrachloride, and formaldehyde.

- Even though acetaldehyde and formaldehyde have some of the highest annual average concentrations among SEWA's pollutants of interest, the annual averages for these pollutants are among the lowest for NMP sites sampling carbonyl compounds. For formaldehyde, only one site (BRCO) has an annual average concentration less than SEWA's annual averages. For acetaldehyde, the only sites with annual average concentrations less than SEWA's are located in Garfield County, Colorado. Few NMP sites have annual average concentrations of these two pollutants less than 1 µg/m^3; SEWA (and BRCO) are the only sites for which both year's annual averages for acetaldehyde and formaldehyde are less than 1 µg/m^3. Similar observations were made in previous NMP reports.

- The first and fourth quarter average benzene concentrations for both years are roughly twice the magnitude of the remaining quarterly average concentrations, indicating that concentrations of benzene tended to be higher during the colder months of the year at SEWA. A review of the data shows that benzene concentrations measured at SEWA span an order of magnitude, ranging from 0.170 µg/m^3 to 1.76 µg/m^3. Of the 39 benzene concentrations greater than 0.5 µg/m^3 measured at SEWA, all but three were measured during the first (20) or fourth (16) quarters of the years. Conversely, only one of the 28 concentrations of benzene less than 0.30 µg/m^3 were measured at SEWA during the first or fourth quarters of 2014. Concentrations of 1,3-butadiene exhibit a similar pattern, though the differences are not statistically significant.

- Concentrations of 1,2-dichloroethane measured during the third quarter of both years are lower than those measured during the rest of the year, based on the quarterly average concentrations. A review of the data shows that all eight non-detects of this pollutant were measured in August or September, with seven of these measured in 2016. Further, 10 of the 12 lowest measured detections were measured in July, August, or September of either year, with the two exceptions measured in early October. Similar observations were made in the 2013 and 2014 NMP reports.

- The first quarter average concentration of arsenic for 2015 is roughly twice the other quarterly average concentrations calculated for 2015. This is true for most of the quarterly averages for 2016 as well. Three of the five arsenic concentrations greater than 2 ng/m^3 measured at SEWA were measured during the first quarter of 2015. Further, one-third of the 24 arsenic concentrations greater than 1 ng/m^3 measured over the two-year period were measured during this calendar quarter.

- For both years, the quarterly average concentration of naphthalene was highest for the first calendar quarter and lowest for the second quarter, though the difference between the two is larger for 2016. Concentrations of naphthalene measured at SEWA range from 13.3 ng/m^3 to 129 ng/m^3. Confidence intervals associated with the quarterly averages of naphthalene indicate that there is considerable variability in the measurements. Naphthalene concentrations greater than 50 ng/m^3 were measured

during seven of the eight calendar quarters, with the exception being the second quarter of 2016.

- Several of the highest concentrations of the pollutants of interest were measured on the same day. For example, the highest concentrations of naphthalene, acetaldehyde, and formaldehyde were all measured at SEWA on November 11, 2016. Higher concentrations of benzene and 1,3-butadiene were also measured on this date. The highest concentrations of arsenic, 1,3-butadiene, and 1,2-dichloroethane were all measured on February 11, 2015, with the second highest benzene concentration also measured on this date.

Tables 4-10 through 4-13 present the NMP sites with the 10 highest annual average concentrations for each of the program-level pollutants of interest. Observations for SEWA from those tables include the following:

- SEWA only appears in Table 4-10 for VOCs for one pollutant; SEWA has the fourth (2016) and seventh (2015) highest annual average concentrations of carbon tetrachloride among sites sampling VOCs. SEWA is the first NMP site outside of Calvert City, Kentucky to appear in Table 4-10 for carbon tetrachloride. A similar observation was made in the last several NMP reports. However, most of the site-specific annual average concentrations for carbon tetrachloride span less than 0.1 $\mu g/m^3$.

- SEWA does not appear in Table 4-11 for carbonyl compounds. As indicated previously, SEWA has some of the lowest annual average concentrations of acetaldehyde and, in particular, formaldehyde among NMP sites sampling these pollutants.

- SEWA does not appear in Table 4-12 for the PAHs pollutants of interest.

- As shown in Table 4-13, SEWA's annual average concentration of arsenic for 2015 ranks tenth highest among NMP sites sampling metals (PM_{10}), with SEWA's annual average for 2016 ranking 11th (though not shown in Table 4-13).

23.3.2 Concentration Comparison

In order to better illustrate how each site's annual average concentrations compare to the program-level averages, a site-specific box plot was created for each of the site-specific pollutants of interest, where applicable. Thus, box plots were created for the pollutants listed in Table 23-3 for SEWA. Figures 23-3 through 23-10 overlay the site's minimum, annual average, and maximum concentrations for each year onto the program-level minimum, first quartile, median, average, third quartile, and maximum concentrations for each pollutant, as described in Section 3.4.2.1, and are discussed below. If an annual average concentration could not be calculated, the range of concentrations are still provided in the figures that follow.

Figure 23-3. Program vs. Site-Specific Average Acetaldehyde Concentrations

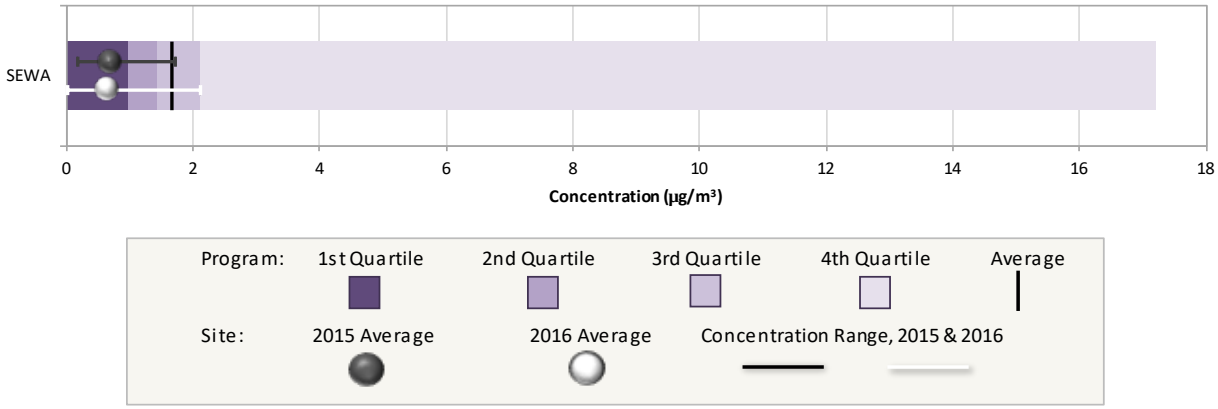


Figure 23-3 presents the box plot for acetaldehyde for SEWA and shows the following:

- The maximum acetaldehyde concentration measured at SEWA is equivalent to the program-level third quartile (2.11 µg/m^3); few acetaldehyde concentrations measured at SEWA are greater than the program-level average concentration (1.67 µg/m^3).
- Both of SEWA's annual average acetaldehyde concentrations are less than the program-level first quartile (0.96 µg/m^3).
- The minimum acetaldehyde concentration measured at SEWA in 2016 (0.0307 µg/m^3) is the second lowest acetaldehyde concentration measured among NMP sites sampling this pollutant.

Figure 23-4. Program vs. Site-Specific Average Arsenic (PM_{10}) Concentrations

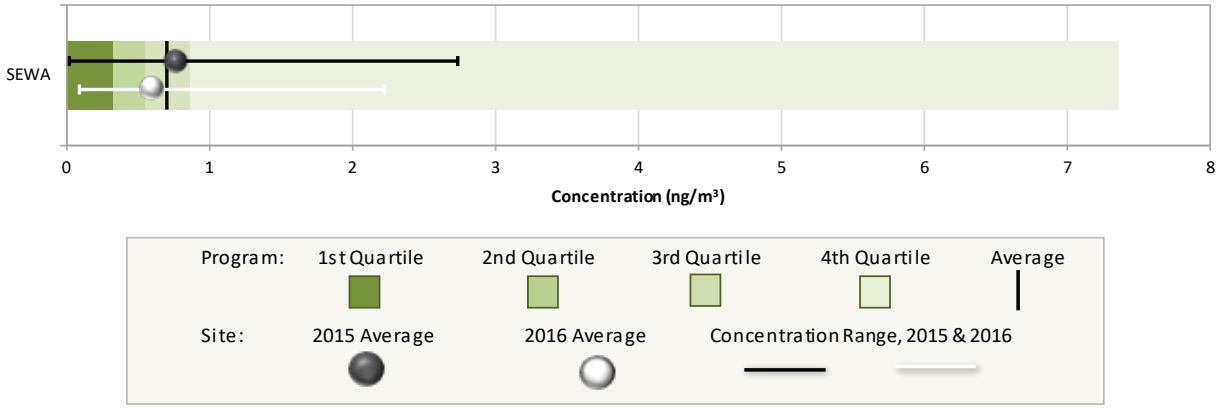


Figure 23-4 presents the box plot for arsenic (PM_{10}) for SEWA and shows the following:

- The range of arsenic concentrations measured at SEWA in 2015 is larger than the range of concentrations measured in 2016.
- SEWA's annual average concentrations of arsenic fall between the program-level median concentration and third quartile, with the program-level average concentration (0.70 ng/m^3) falling in between SEWA's two annual averages.

- There were no non-detects of arsenic measured at SEWA.

Figure 23-5. Program vs. Site-Specific Average Benzene Concentrations

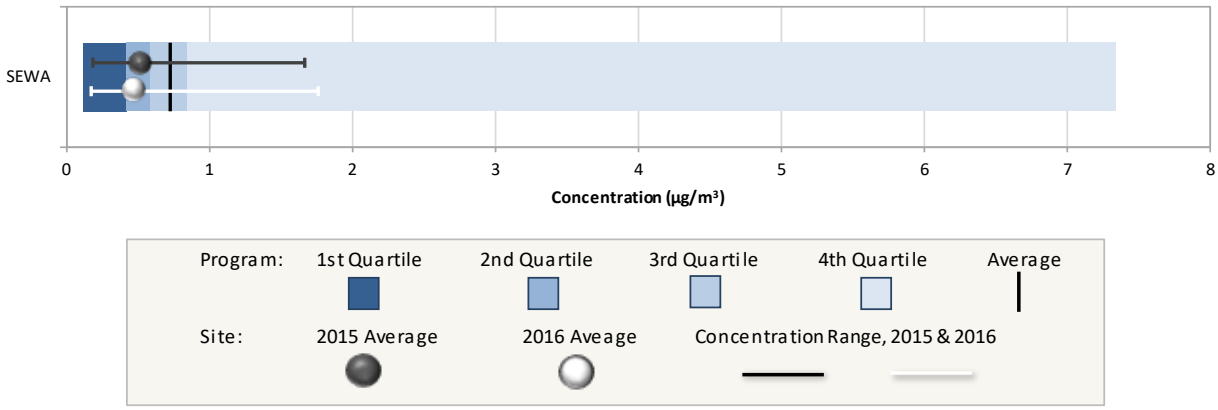


Figure 23-5 presents the box plot for benzene for SEWA and shows the following:

- All benzene concentrations measured at SEWA in 2015 and 2016 are less than 2 µg/m^3.

- The annual average benzene concentrations for SEWA fall between the program-level first quartile (0.42 µg/m^3) and the program-level median concentration (0.58 µg/m^3). SEWA is one of only five NMP sites with an annual average concentration of benzene less than 0.5 µg/m^3.

Figure 23-6. Program vs. Site-Specific Average 1,3-Butadiene Concentrations

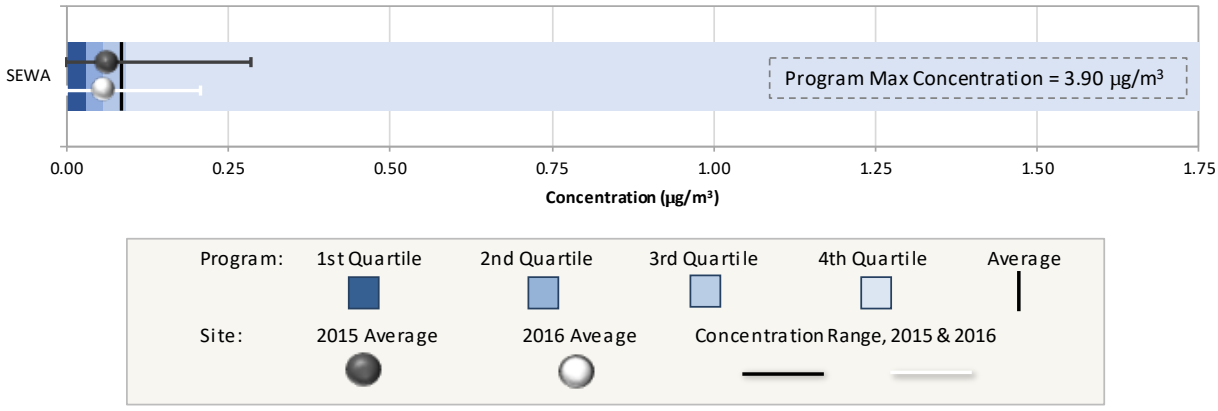


Figure 23-6 presents the box plot for 1,3-butadiene for SEWA and shows the following:

- The program-level maximum 1,3-butadiene concentration (3.90 µg/m^3) is not shown directly on the box plot in Figure 23-6 because the scale of the box plot would be too large to readily observe data points at the lower end of the concentration range. Thus, the scale of the box plot has been reduced.

- The maximum 1,3-butadiene concentration measured at SEWA is an order of magnitude less than the maximum concentration measured at the program-level.

- Both annual average concentrations of 1,3-butadiene for SEWA are just greater than the program-level median concentration and less than the program-level average concentration.

- Five non-detects of 1,3-butadiene were measured at SEWA, two in 2015 and three in 2016.

Figure 23-7. Program vs. Site-Specific Average Carbon Tetrachloride Concentrations

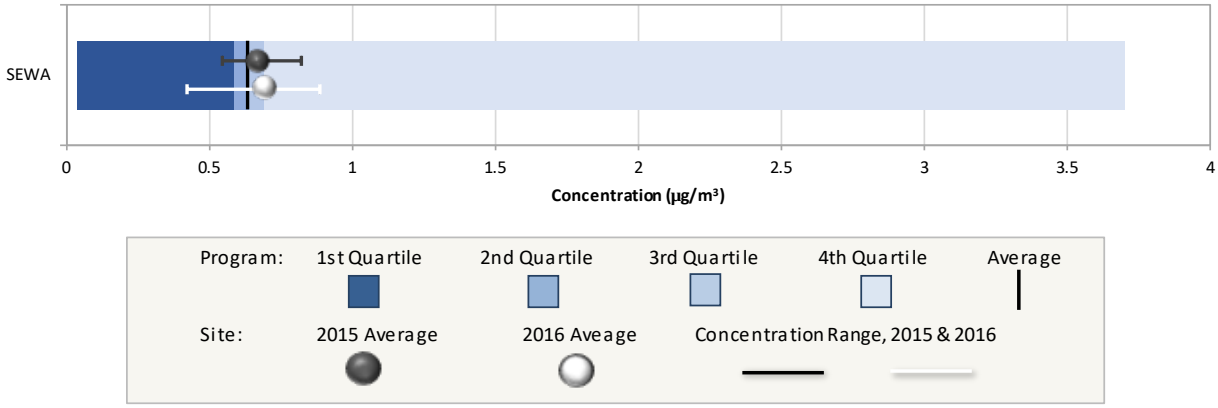


Figure 23-7 presents the box plot for carbon tetrachloride for SEWA and shows the following:

- The entire range of carbon tetrachloride concentrations measured at SEWA spans less than 0.5 µg/m^3. The range of concentrations measured in 2015 is smaller than the range measured in 2016.

- Both annual average concentrations of carbon tetrachloride for SEWA are greater than the program-level average concentration (0.64 µg/m^3). SEWA's 2016 annual average is also just greater than the program-level third quartile. However, less than 0.06 µg/m^3 separates SEWA's annual averages and these program-level summary statistics.

Figure 23-8. Program vs. Site-Specific Average 1,2-Dichloroethane Concentrations

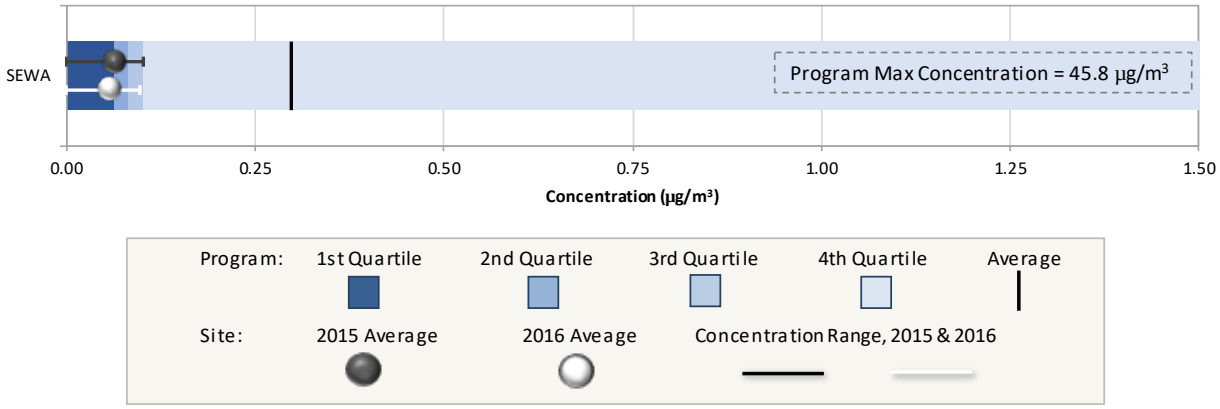


Figure 23-8 presents the box plot for 1,2-dichloroethane for SEWA and shows the following:

- The scale of the box plot in Figure 23-8 has also been reduced to allow for the observation of data points at the lower end of the concentration range, as the program-level maximum 1,2-dichloroethane concentration (45.8 µg/m^3) is considerably greater than the majority of measurements.

- The maximum 1,2-dichloroethane concentration measured at SEWA is equivalent to the program-level third quartile (0.101 µg/m^3); the remaining 1,2-dichloroethane concentrations measured at SEWA are less than 0.1 µg/m^3.

- SEWA's annual average concentrations of 1,2-dichloroethane are similar to the program-level first quartile. Note that the program-level average concentration of 0.30 µg/m^3 is being driven by measurements at the upper end of the concentration range.

- Eight non-detects of 1,2-dichloroethane were measured at SEWA, one in 2015 and seven in 2016.

Figure 23-9. Program vs. Site-Specific Average Formaldehyde Concentrations

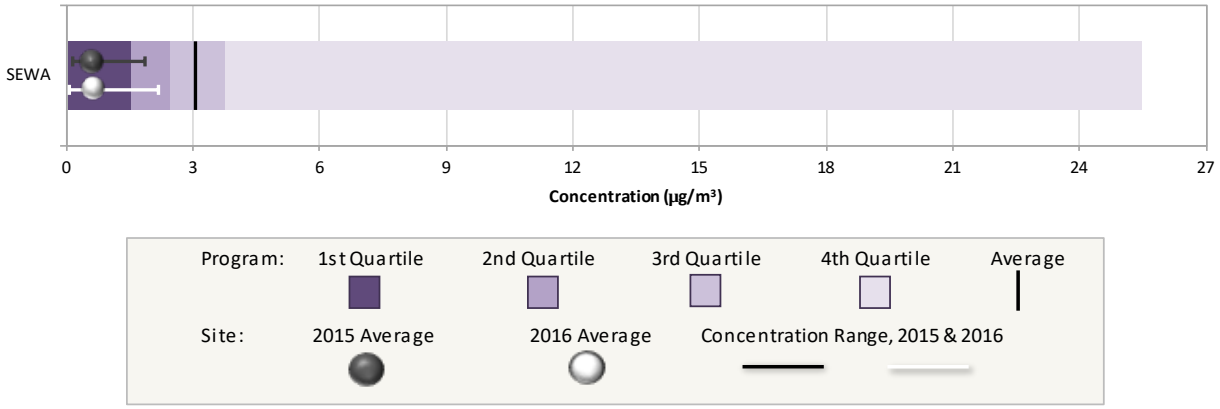


Figure 23-9 presents the box plot for formaldehyde for SEWA and shows the following:

- The entire range of formaldehyde concentrations measured at SEWA is less than the program-level median concentration of 2.47 µg/m^3. A single formaldehyde concentration measured at SEWA is greater than 2 µg/m^3.

- Both annual average concentrations for SEWA are less than the program-level first quartile (1.54 µg/m^3); SEWA's annual averages are less than half the program-level first quartile. One only NMP site (BRCO) has an annual average concentration less than SEWA's annual averages.

Figure 23-10. Program vs. Site-Specific Average Naphthalene Concentrations

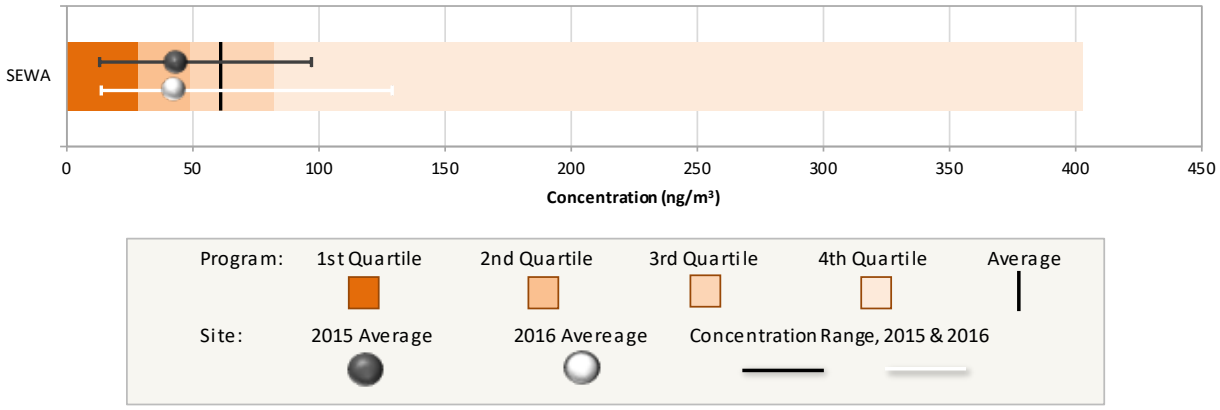


Figure 23-10 presents the box plot for naphthalene for SEWA and shows the following:

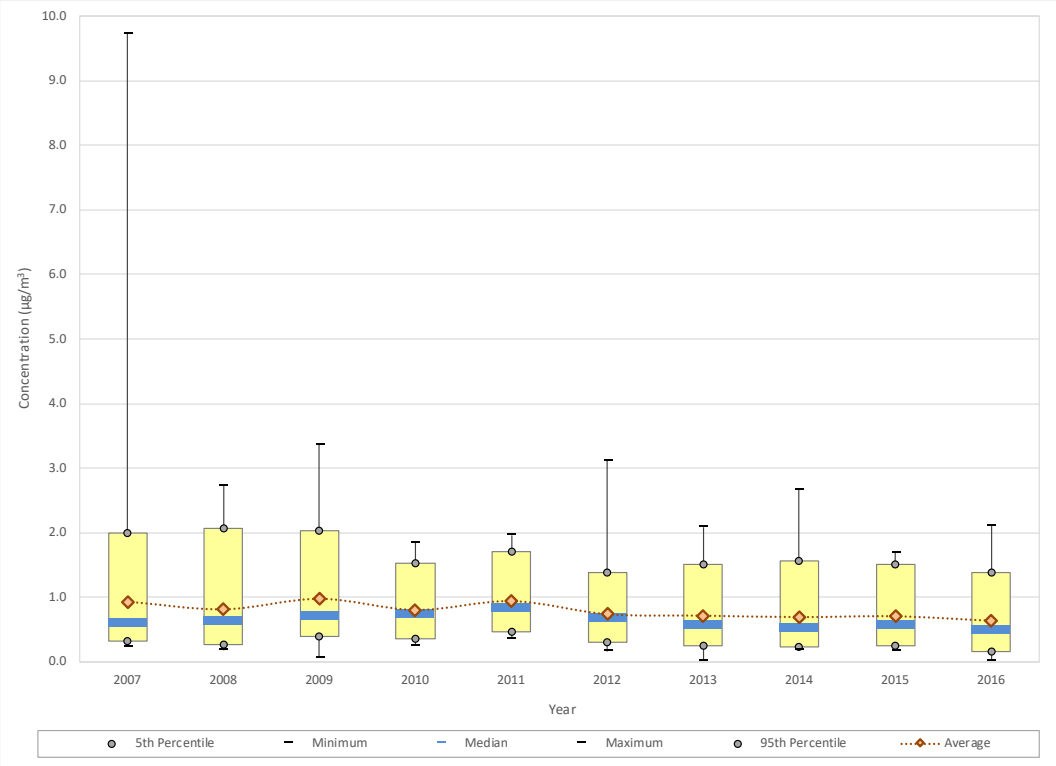
- The two naphthalene concentrations greater than 100 ng/m^3 measured at SEWA were both measured in 2016. These measurements are considerably less than the maximum naphthalene concentration measured across the program.

- SEWA's annual average concentrations of naphthalene for 2015 and 2016 are similar to each other, both of which are just less than the program-level median concentration of 48.90 ng/m^3.

23.3.3 Concentration Trends

A site-specific trends evaluation was completed for sites that have sampled one or more of the pollutants of interest for 5 consecutive years or longer, as described in Section 3.4.2.2. Sampling for PM_{10} metals, VOCs, and carbonyl compounds under the NMP began at SEWA in 2007 and sampling for PAHs began in 2008. Thus, Figures 23-11 through 23-18 present the 1-year statistical metrics for each of the pollutants of interest for SEWA. If sampling began mid-year, a minimum of 6 months of sampling is required for inclusion in the trends analysis; in these cases, a 1-year average concentration is not provided, although the range and percentiles are still presented.

Figure 23-11. Yearly Statistical Metrics for Acetaldehyde Concentrations Measured at SEWA



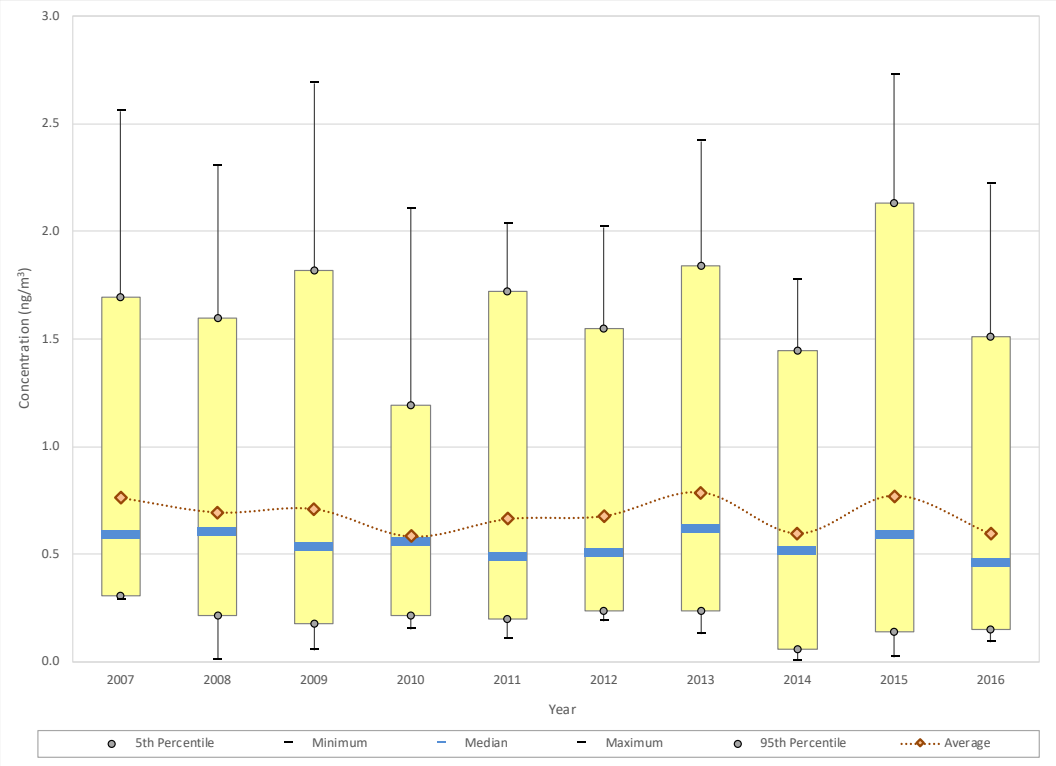
Observations from Figure 23-11 for acetaldehyde concentrations measured at SEWA include the following:

- The maximum acetaldehyde concentration was measured at SEWA on July 17, 2007 (9.73 µg/m^3). The next highest concentration is considerably less (3.38 µg/m^3, measured in September 2009). One additional acetaldehyde concentration greater than 3 µg/m^3 has been measured at SEWA (September 2012).

- The 1-year average concentration has a slight undulating pattern through 2012, with years with slightly lower concentrations alternating with years with slightly higher concentrations. Through 2012, the 1-year average concentrations ranged from 0.74 µg/m^3 (2012) to 0.98 µg/m^3 (2009). The median concentration exhibits a steady increasing trend for the first 5 years of sampling, ranging from 0.61 µg/m^3 (2007) to 0.85 µg/m^3 (2011), before decreasing considerably for 2012.

- Although the 1-year average concentration has varied by only 0.1 µg/m^3 over the last five years of sampling, the 1-year average for 2016 is at a minimum compared to other years of sampling (0.64 µg/m^3). In fact, several of the statistical parameters are at a minimum for 2016, including the 5th and 95th percentiles and the 1-year average and median concentrations.

Figure 23-12. Yearly Statistical Metrics for Arsenic (PM_{10}) Concentrations Measured at SEWA



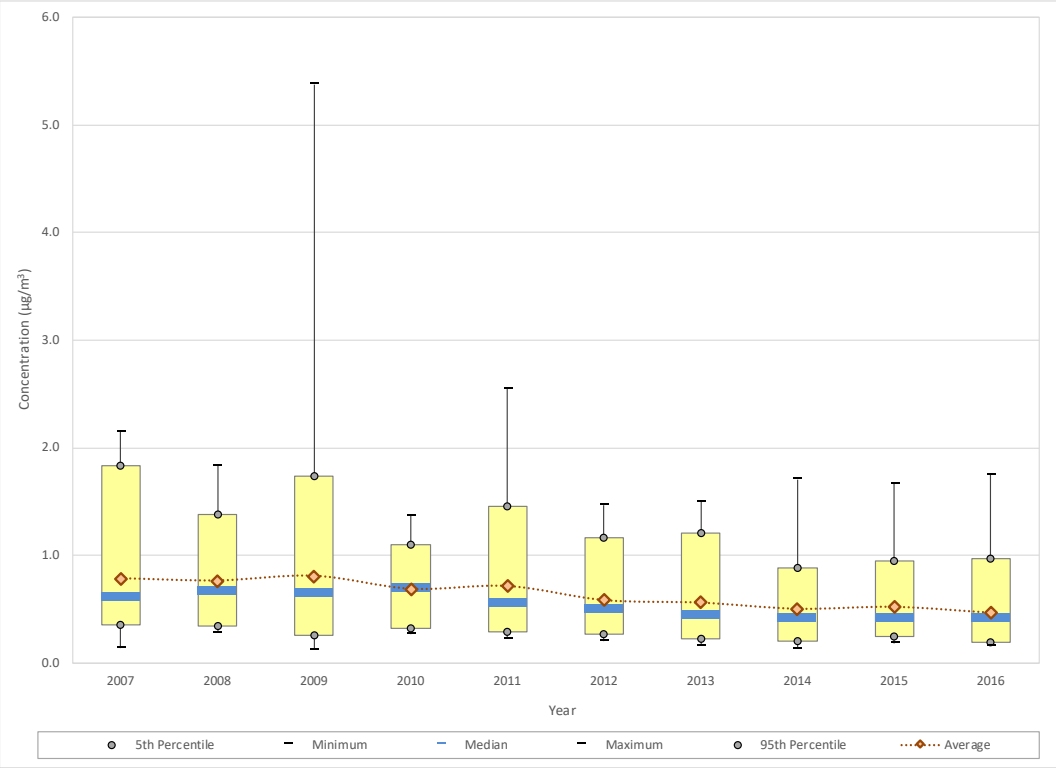
Observations from Figure 23-12 for arsenic (PM_{10}) concentrations measured at SEWA include the following:

- The maximum arsenic concentration was measured at SEWA on February 11, 2015 (2.73 ng/m^3), although a similar concentration was also measured in 2009 (2.69 ng/m^3). In total, 16 arsenic concentrations greater than 2 ng/m^3 have been measured at SEWA, at least one in each year of sampling except 2014.

- There have been no non-detects of arsenic measured at SEWA since the onset of sampling, including 2008 and 2014, when the minimum concentration is less than other years. For these two years, the minimum concentration of arsenic is around 0.01 ng/m^3.

- Despite the fluctuations shown, the 1-year average concentration of arsenic for SEWA has only varied by about 0.2 ng/m^3, ranging from 0.58 ng/m^3 (2010) to 0.79 ng/m^3 (2013). Confidence intervals indicate that the changes are not statistically significant. The median concentration has varied less, from 0.47 ng/m^3 (2016) to 0.63 ng/m^3 (2013); 2016 is the first time that the median concentration is less than 0.5 ng/m^3.

Figure 23-13. Yearly Statistical Metrics for Benzene Concentrations Measured at SEWA



Observations from Figure 23-13 for benzene concentrations measured at SEWA include the following:

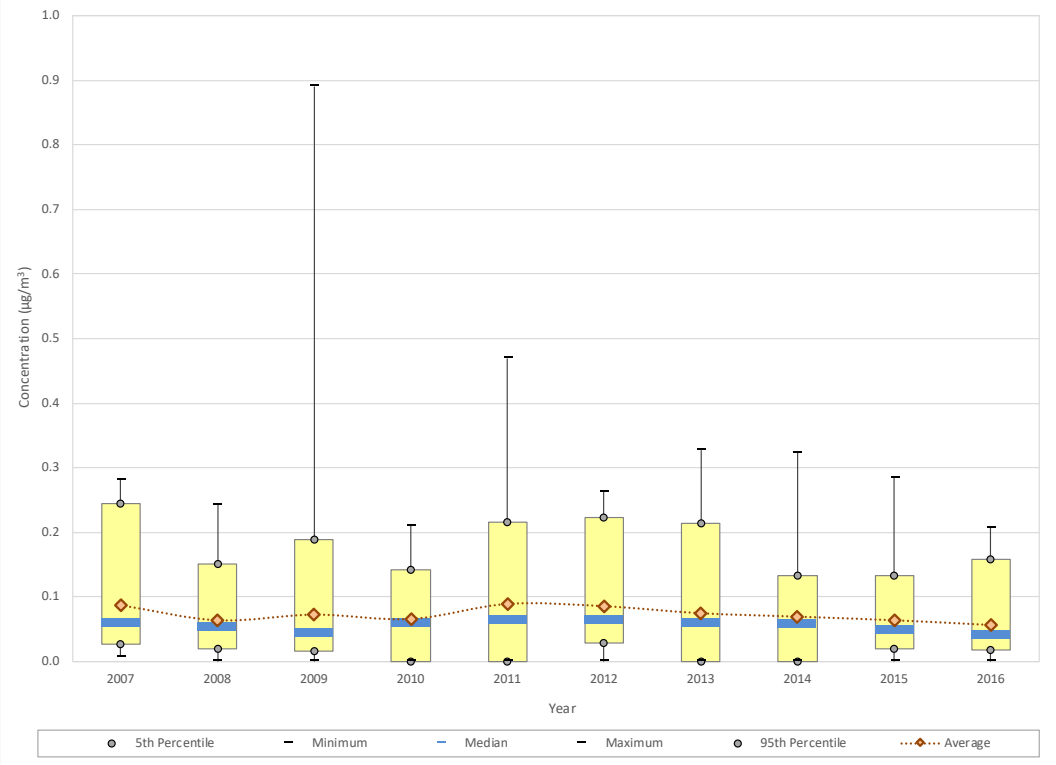
- The maximum benzene concentration was measured at SEWA on January 19, 2009 (5.38 µg/m^3), which is the same day the maximum arsenic concentration was measured. The next highest concentration is roughly half as high (2.55 µg/m^3, measured in January 2011). In total, five benzene concentrations greater than 2 µg/m^3 have been measured at SEWA.

- Overall, benzene concentrations have a slight decreasing trend at SEWA. Despite differences in the magnitude of concentrations measured, little change in the 1-year average concentration is shown for the first three years of sampling. The year with the largest range of benzene concentrations measured (2009) is followed by the year with the small range of concentrations measured (2010). The range of measurements expands again for 2011; between 2012 and 2016, the range of concentrations measured each year changes little. The 1-year average concentration of benzene is highest for 2009 (0.81 µg/m^3) and lowest for 2016, when the 1-year average is less than 0.50 µg/m^3 for the first time (0.47 µg/m^3).

- Concentrations of benzene appear to have a seasonal trend at SEWA. Of the 72 benzene concentrations greater than 1 µg/m^3, 61 have been measured during the colder months of the year, either during the first quarter (27) or fourth quarter (34) of any given year. Conversely, few of the lower benzene concentrations have been measured during the warmer months of the year. Of the 71 benzene concentrations

less than 0.3 µg/m^3 measured at SEWA, 66 have been measured during the warmer months of the year, during the second (23) and third (43) quarters of the year.

Figure 23-14. Yearly Statistical Metrics for 1,3-Butadiene Concentrations Measured at SEWA



Observations from Figure 23-14 for 1,3-butadiene concentrations measured at SEWA include the following:

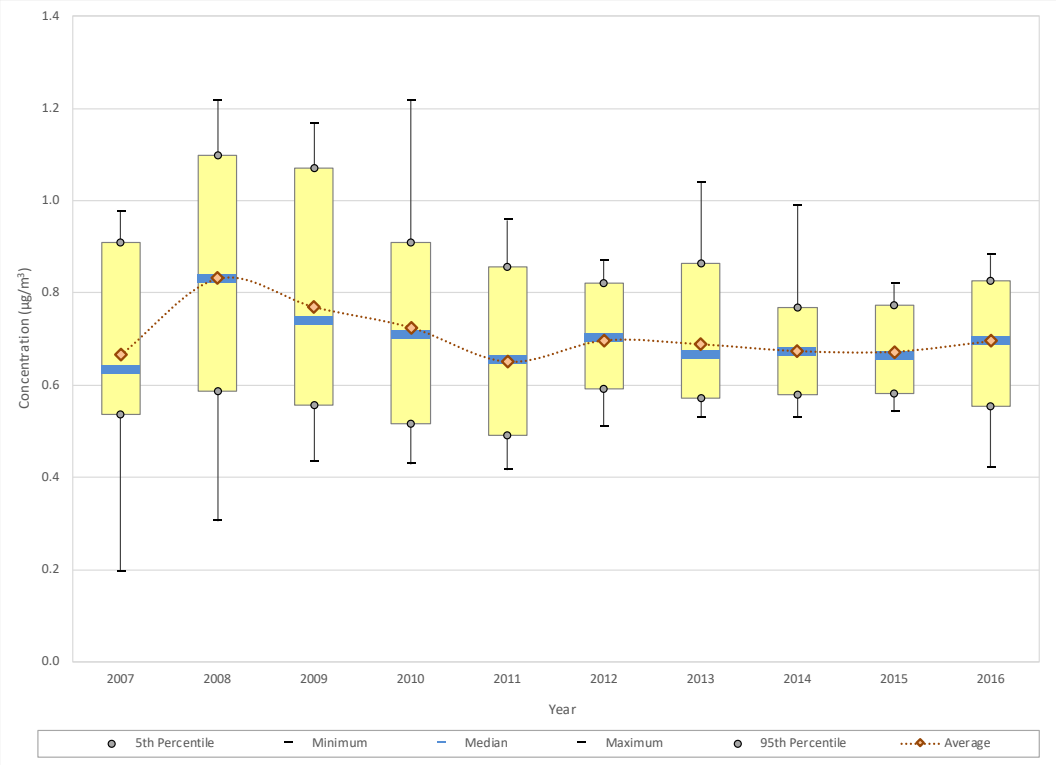
- The maximum 1,3-butadiene concentration (0.89 µg/m^3) was measured at SEWA on the same day as the maximum arsenic and benzene concentrations were measured, January 19, 2009. The next highest concentration was approximately half as high (0.47 µg/m^3) and was measured on the same day in January 2011 as the second highest benzene concentration.

- At least one non-detect of 1,3-butadiene has been measured at SEWA each year since the onset of sampling, with the exception of 2007, as indicated by the minimum concentration. For 2010, 2011, 2013, and 2014, both the minimum and 5th percentile are zero, indicating that at least 5 percent of the measurements were non-detects. For each of these years, the percentage of non-detects ranged from 10 percent to 15 percent.

- The 1-year average concentration has an undulating pattern over the first several years of sampling, when a year with a higher 1-year average concentration is followed by a year with a lower 1-year average. Between 2007 and 2011, the 1-year average concentration ranged from 0.06 µg/m^3 (2008) to 0.09 µg/m^3 (2011).

- After 2011, the 1-year average concentration has a steady decreasing trend, and is at a minimum for 2016. The median concentration exhibits a similar trend.

Figure 23-15. Yearly Statistical Metrics for Carbon Tetrachloride Concentrations Measured at SEWA



Observations from Figure 23-15 for carbon tetrachloride concentrations measured at SEWA include the following:

- The maximum carbon tetrachloride concentration (1.22 µg/m^3) has been measured twice at SEWA, once in 2008 and once in 2010. Nineteen concentrations of carbon tetrachloride greater than 1.0 µg/m^3 have been measured at SEWA since the onset of sampling in 2007. All but two of these were measured in 2008 and 2009, with one each in 2010 and 2013.

- All of the statistical metrics increased from 2007 to 2008. Eleven concentrations measured in 2008 were greater than the maximum concentration measured in 2007. In addition, the number of carbon tetrachloride concentrations greater than 0.75 µg/m^3 increased from 12 in 2007 to 43 for 2008.

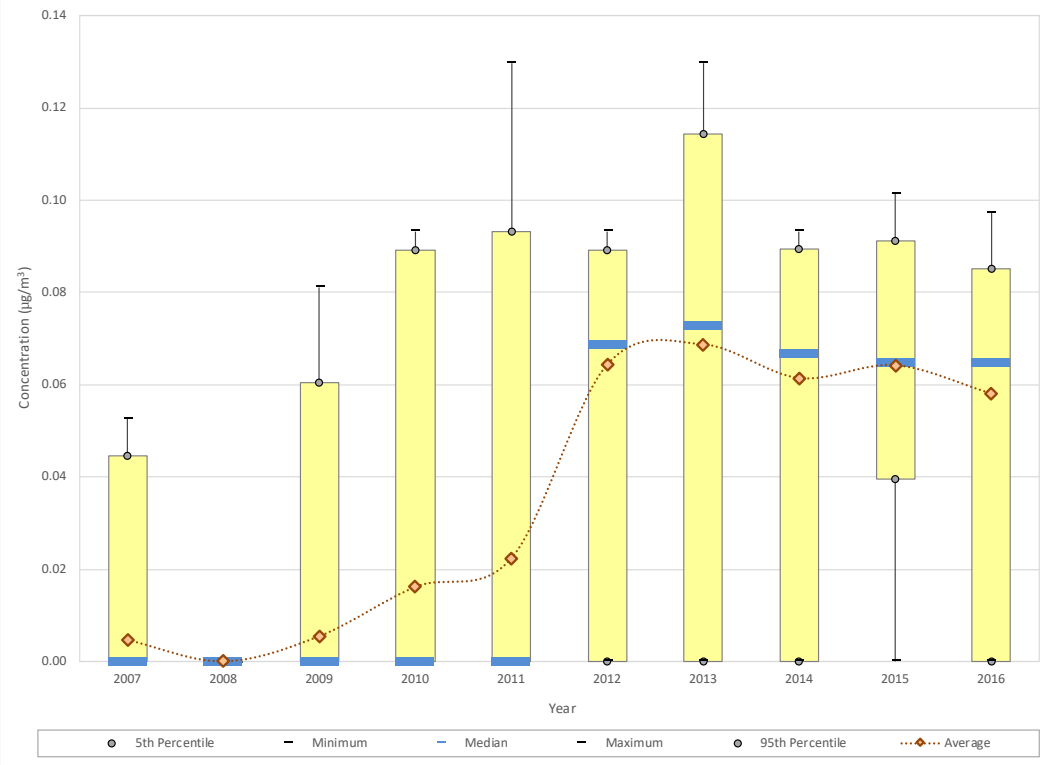
- A steady decreasing trend in the concentrations is shown between 2008 and 2011, when the 1-year average concentration is at a minimum (0.65 µg/m^3).

- The range of measurements tightened considerably for 2012. Yet, both the 1-year average and median concentrations exhibit significant increases. As the number of concentrations falling into the 0.65 µg/m^3 to 0.85 µg/m^3 range increased, from 29 for

2011 to 42 in 2012, the number of concentrations less than 0.6 µg/m^3 fell from 20 to seven during this time frame.

- After 2012, the 1-year average concentration exhibits slight decreases each year, until returning to 2012 levels for 2016.

Figure 23-16. Yearly Statistical Metrics for 1,2-Dichloroethane Concentrations Measured at SEWA



Observations from Figure 23-16 for 1,2-dichloroethane concentrations measured at SEWA include the following:

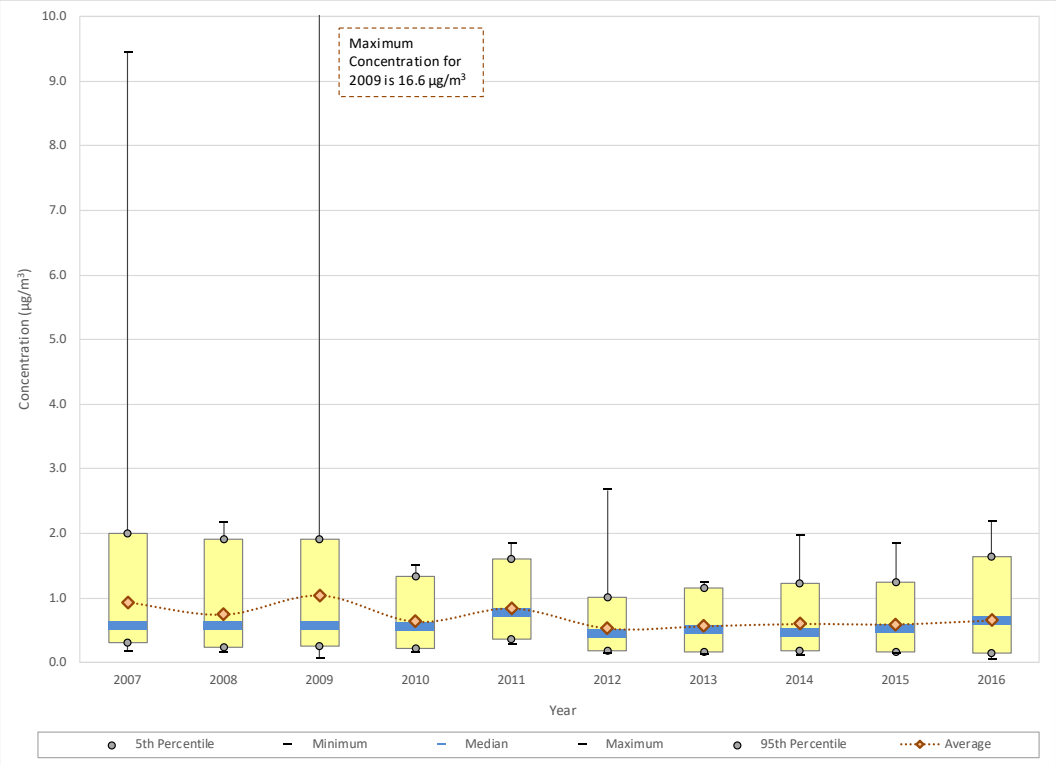
- The minimum, 5th percentile, and median concentrations are zero for 2007 through 2011. This indicates that at least half of the measurements were non-detects. In 2008, there were no measured detections of 1,2-dichloroethane. The percentage of measured detections in 2007 and 2009 was around 10 percent, after which the percentage increased. For 2012, the percentage of measured detections is 93 percent, a considerable increase from 26 percent in 2011. This percentage leveled off somewhat for 2013 and 2014 (at 88 percent each) before reaching a maximum of 98 percent for 2015 (note the 5th percentile is greater than zero for the first time). The percentage of measured detections decreased to 88 percent for 2016.

- As the number of measured detections increased, particularly for 2012 and the years that follow, the median and 1-year average concentrations increased correspondingly.

- The median concentration is greater than the 1-year average concentration for each of the last five years of sampling. This is because there were still several non-detects (or

zeros) factoring into the 1-year average concentration for these years, which can pull an average down in a similar manner that an outlier can drive an average upward, while the range of measured detections is rather small.

Figure 23-17. Yearly Statistical Metrics for Formaldehyde Concentrations Measured at SEWA



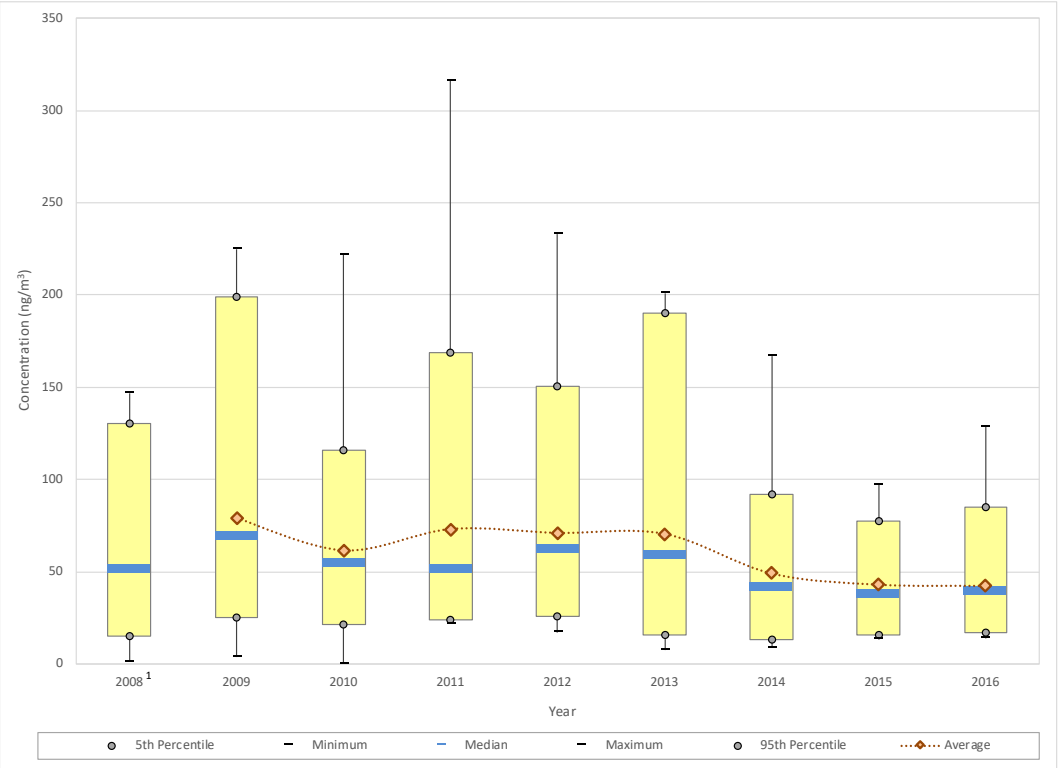
Observations from Figure 23-17 for formaldehyde concentrations measured at SEWA include the following:

- The maximum formaldehyde concentration measured at SEWA was measured on January 13, 2009 (16.6 µg/m^3). The next highest concentration (9.44 µg/m^3) was measured on the same day in 2007 as the maximum acetaldehyde concentration. Only one other formaldehyde concentration greater than 3 µg/m^3 has been measured at SEWA and was also measured in 2009. In total, 10 concentrations greater than 2 µg/m^3 have been measured at SEWA since the onset of carbonyl compound sampling, and all but two of these were measured prior to 2010.

- The 1-year average concentration has an undulating pattern through 2012, with a "down" year followed by an "up" year. Between 2007 and 2012, the 1-year average concentration varied considerably, from 0.53 µg/m^3 (2012) to 1.04 µg/m^3 (2009). The median concentration is static during the first four years of sampling, with each year's median just less than 0.6 µg/m^3, after which it too exhibits the up/down pattern.

- The 1-year average formaldehyde concentration exhibits a very subtle increase between 2012 and 2016, although the changes are not statistically significant.

Figure 23-18. Yearly Statistical Metrics for Naphthalene Concentrations Measured at SEWA



[1] A 1-year average is not presented because sampling under the NMP did not begin until March 2008.

Observations from Figure 23-18 for naphthalene concentrations measured at SEWA include the following:

- SEWA began sampling PAHs under the NMP in March 2008. Because a full year's worth of data is not available, a 1-year average concentration is not presented for 2008, although the range of measurements is provided.

- The maximum naphthalene concentration measured at SEWA was measured in 2011 (317 ng/m^3). This is the only naphthalene concentration greater than 250 ng/m^3 measured at this site. Eight additional concentrations greater than 200 ng/m^3 have been measured at SEWA, with each measured between 2009 and 2013.

- Each of the statistical parameters shown exhibits an increase from 2008 to 2009. Although the range of concentrations measured in 2009 is similar to those measured in 2010, the 95th percentile decreased by almost half from one year to the next. The number of naphthalene concentrations greater than 100 ng/m^3 decreased by nearly two-thirds, decreasing from 19 in 2009 to seven in 2010.

- With the exception of the median concentration, each of the statistical parameters exhibits an increase for 2011, with the 1-year average concentration nearly returning to 2009 levels. This is partially driven by the maximum concentration measured in 2011. Another factor is the minimum concentration measured in 2011, which is considerably higher than the minimum concentration measured in the previous two

years. The median concentration decreased each year between 2009 and 2011, as naphthalene concentrations less than 50 ng/m^3 account for an increasing number of measurements during this time.

- Little change in the 1-year average concentration is shown between 2011 and 2013, after which a significant decrease is shown for 2014, when the 1-year average concentration is less than 50 ng/m^3 for the first time (as is the median concentration). Only one naphthalene concentration greater than 100 ng/m^3 was measured in 2014, with most of the previous years having 10 or more. Additional decreases are shown for 2015 (when concentrations greater than 100 ng/m^3 were not measured) and 2016 (when the 1-year average concentration is at a minimum). With the exception of the minimum concentration, each of the statistical parameters is at a minimum in 2014 (5th percentile), 2015 (median, maximum, and 95th percentile), or 2016 (1-year average).

23.4 Additional Risk-Based Screening Evaluations

The following risk-based screening evaluations were conducted to characterize risk related to the air toxics measured at the Washington monitoring site. Refer to Sections 3.2, 3.4.2.3, and 3.4.2.4 for definitions and explanations regarding the various toxicity factors, time frames, and calculations associated with these risk-based screenings.

23.4.1 Cancer Risk and Noncancer Hazard Approximations

For the pollutants of interest for the Washington site, risk was examined by calculating cancer risk and noncancer hazard approximations for each year annual average concentrations could be calculated. These approximations can be used as risk estimates for cancer and noncancer effects attributable to the pollutants of interest. Although the use of these approximations is limited, they may help identify where policy-makers may want to shift their air monitoring priorities. Refer to Section 3.4.2.3 for an explanation of how cancer risk and noncancer hazard approximations are calculated and what limitations are associated with them. Annual averages, cancer UREs and/or noncancer RfCs, and cancer risk and noncancer hazard approximations are presented in Table 23-4, where applicable. Cancer risk approximations are presented as probabilities while the noncancer hazard approximations are ratios and thus, unitless values.

Table 23-4. Risk Approximations for the Washington Monitoring Site

Pollutant	Cancer URE $(\mu g/m^3)^{-1}$	Noncancer RfC (mg/m^3)	2015				2016			
			# of Measured Detections vs. # of Samples	Annual Average $(\mu g/m^3)$	Risk Approximations		# of Measured Detections vs. # of Samples	Annual Average $(\mu g/m^3)$	Risk Approximations	
					Cancer (in-a-million)	Noncancer (HQ)			Cancer (in-a-million)	Noncancer (HQ)
Seattle, Washington - SEWA										
Acetaldehyde	0.0000022	0.009	59/59	0.71 ± 0.10	1.55	0.08	61/61	0.64 ± 0.10	1.40	0.07
Benzene	0.0000078	0.03	57/57	0.52 ± 0.07	4.03	0.02	61/61	0.47 ± 0.07	3.66	0.02
1,3-Butadiene	0.00003	0.002	55/57	0.06 ± 0.01	1.90	0.03	58/61	0.06 ± 0.01	1.72	0.03
Carbon Tetrachloride	0.000006	0.1	57/57	0.67 ± 0.02	4.03	0.01	61/61	0.70 ± 0.02	4.17	0.01
1,2-Dichloroethane	0.000026	2.4	56/57	0.06 ± <0.01	1.67	<0.01	54/61	0.06 ± 0.01	1.51	<0.01
Formaldehyde	0.000013	0.0098	59/59	0.60 ± 0.09	7.75	0.06	61/61	0.66 ± 0.10	8.53	0.07
Arsenic (PM_{10})[a]	0.0043	0.000015	58/58	0.77 ± 0.16	3.32	0.05	58/58	0.60 ± 0.12	2.56	0.04
Naphthalene[a]	0.000034	0.003	57/57	43.30 ± 5.54	1.47	0.01	61/61	42.59 ± 6.03	1.45	0.01

[a] Average concentrations provided below the blue line for this pollutant are presented in ng/m^3 for ease of viewing.

Observations from Table 23-4 for SEWA include the following:

- The pollutants with the highest annual average concentrations for SEWA are acetaldehyde, carbon tetrachloride, and formaldehyde, although the order varies by year.

- Despite its comparatively low annual averages, the pollutant with the highest cancer risk approximation for each year is formaldehyde. SEWA's cancer risk approximations for formaldehyde are among the lowest site-specific cancer risk approximations for this pollutant; SEWA is one of only two sites for which the cancer risk approximations for formaldehyde are less than 10 in-a-million.

- The noncancer hazard approximations for SEWA are all considerably less than 1.0, with the highest calculated for acetaldehyde (0.08) for 2015. This indicates that no adverse noncancer health effects are expected from these individual pollutants.

23.4.2 Risk-Based Emissions Assessment

In addition to the risk-based screening discussed above, this section presents an evaluation of county-level emissions based on cancer and noncancer toxicity, respectively. Table 23-5 presents the 10 pollutants with the highest emissions from the 2014 NEI (version 1) that have cancer toxicity factors. Table 23-5 also presents the 10 pollutants with the highest toxicity-weighted emissions, based on the weighting schema described in Section 3.4.2.4. Lastly, Table 23-5 provides the pollutants of interest with the highest cancer risk approximations (in-a-million) for SEWA, as presented in Table 23-4. Cancer risk approximations for 2015 are presented in green while approximations for 2016 are in white. The emissions, toxicity-weighted emissions, and cancer risk approximations are shown in descending order in Table 23-5. Table 23-6 presents similar information but is limited to those pollutants with noncancer toxicity factors.

Because not all pollutants have both cancer and noncancer toxicity factors, the highest emitted pollutants in the cancer table may be different from the noncancer table, although the actual quantity of emissions is the same. The cancer risk and noncancer hazard approximations based on each site's annual averages are limited to the pollutants of interest identified for each site. In addition, the cancer risk and noncancer hazard approximations are limited to those pollutants with enough data to meet the criteria for annual averages to be calculated. A more in-depth discussion of this analysis is provided in Section 3.4.2.4. Similar to the cancer risk and noncancer hazard approximations provided in Section 23.4.1, this analysis may help policy-makers prioritize their air monitoring activities.

Table 23-5. Top 10 Emissions, Toxicity-Weighted Emissions, and Cancer Risk Approximations for Pollutants with Cancer UREs for the Washington Monitoring Site

Top 10 Total Emissions for Pollutants with Cancer UREs (County-Level)		Top 10 Cancer Toxicity-Weighted Emissions (County-Level)		Top 10 Cancer Risk Approximations Based on Annual Average Concentrations (Site-Specific)[1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Cancer Toxicity Weight**	**Pollutant**	**Cancer Risk Approximation (in-a-million)**
Seattle, Washington (King County) - SEWA					
Benzene	814.74	Formaldehyde	1.01E-02	Formaldehyde	8.53
Formaldehyde	780.67	Benzene	6.35E-03	Formaldehyde	7.75
Acetaldehyde	463.17	POM, Group 3	5.39E-03	Carbon Tetrachloride	4.17
Ethylbenzene	376.38	Naphthalene	4.82E-03	Carbon Tetrachloride	4.03
Naphthalene	141.81	1,3-Butadiene	3.71E-03	Benzene	4.03
1,3-Butadiene	123.76	Hexavalent Chromium, PM	2.51E-03	Benzene	3.66
Bis(2-ethylhexyl) phthalate, gas	95.13	POM, Group 2b	1.73E-03	Arsenic	3.32
POM, Group 2b	19.63	POM, Group 5a	1.24E-03	Arsenic	2.56
POM, Group 2d	13.43	POM, Group 2d	1.18E-03	1,3-Butadiene	1.90
2,4-Toluene diisocyanate	8.14	Acetaldehyde	1.02E-03	1,3-Butadiene	1.72

[1] Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Table 23-6. Top 10 Emissions, Toxicity-Weighted Emissions, and Noncancer Hazard Approximations for Pollutants with Noncancer RfCs for the Washington Monitoring Site

Top 10 Total Emissions for Pollutants with Noncancer RfCs (County-Level)		Top 10 Noncancer Toxicity-Weighted Emissions (County-Level)		Top 10 Noncancer Hazard Approximations Based on Annual Average Concentrations (Site-Specific) [1]	
Pollutant	**Emissions (tpy)**	**Pollutant**	**Noncancer Toxicity Weight**	**Pollutant**	**Noncancer Hazard Approximation (HQ)**
Seattle, Washington (King County) - SEWA					
Toluene	2,384.23	Acrolein	2,917,859.78	Acetaldehyde	0.08
Xylenes	1,360.91	2,4-Toluene diisocyanate	116,325.71	Acetaldehyde	0.07
Methanol	965.12	Formaldehyde	79,660.05	Formaldehyde	0.07
Benzene	814.74	1,3-Butadiene	61,882.43	Formaldehyde	0.06
Formaldehyde	780.67	Acetaldehyde	51,463.20	Arsenic	0.05
Acetaldehyde	463.17	Cyanide Compounds, gas	51,064.88	Arsenic	0.04
Hexane	437.73	Naphthalene	47,269.92	1,3-Butadiene	0.03
Ethylbenzene	376.38	Benzene	27,158.03	1,3-Butadiene	0.03
Naphthalene	141.81	Lead, PM	15,660.71	Benzene	0.02
Ethylene glycol	132.33	Nickel, PM	14,362.01	Benzene	0.02

[1] Green shading represents a risk approximation based on a 2015 annual average concentration and no shading represents a 2016 risk approximation.

Observations from Table 23-5 for SEWA include the following:

- Benzene, formaldehyde, and acetaldehyde are the highest emitted pollutants with cancer UREs in King County.

- The pollutants with the highest toxicity-weighted emissions (of the pollutants with cancer UREs) for King County are formaldehyde, benzene, and POM, Group 3.

- Seven of the highest emitted pollutants also have the highest toxicity-weighted emissions for King County.

- Formaldehyde has the highest cancer risk approximations for SEWA, the highest toxicity-weighted emissions for King County, and ranks second for quantity emitted. Benzene and 1,3-butadiene also appear on all three lists.

- Carbon tetrachloride and arsenic, which also have some of the highest cancer risk approximations for SEWA, do not appear on either emissions-based list.

- Several POM Groups appear on the emissions-based lists for King County, including POM, Group 2b. POM, Group 2b includes several PAHs sampled for at SEWA including acenaphthene and fluorene, both of which failed a single a screen (and thus, were not identified as pollutants of interest for SEWA).

Observations from Table 23-6 for SEWA include the following:

- Toluene, xylenes, and methanol are the highest emitted pollutants with noncancer RfCs in King County.

- Acrolein is the pollutant with the highest toxicity-weighted emissions (of the pollutants with noncancer RfCs) for King County, followed by 2,4-toluene diisocyante and formaldehyde. Although acrolein was sampled for at SEWA, this pollutant was excluded from the pollutants of interest designation, and thus subsequent risk-based screening evaluations, due to questions about the consistency and reliability of the measurements, as discussed in Section 3.2.

- Four of the highest emitted pollutants also have the highest toxicity-weighted emissions for King County.

- Acetaldehyde, formaldehyde, and benzene appear on all three lists in Table 23-6.

- 1,3-Butadiene is also a pollutant of interest for SEWA that also appears among those with the highest toxicity-weighted emissions but does not appear among the highest emitted (of those with a noncancer RfC).

- Arsenic is a pollutant of interest for SEWA that appears on neither emissions-based list.

23.5 Summary of the 2015-2016 Monitoring Data for SEWA

Results from several of the data analyses described in this section include the following:

- *Fifteen pollutants failed at least one screen for SEWA.*
- *All of the pollutants of interest for SEWA have annual average concentrations less than 1 µg/m^3.*
- *The annual average concentrations of several of SEWA's pollutants of interest are among the lowest compared to other NMP sites sampling these pollutants.*
- *Concentrations of benzene exhibit an overall decreasing trend over the period sampling period at SEWA. Concentrations of 1,3-butadiene and naphthalene have a decreasing trend in recent years.*

24.0 Data Quality

This section discusses the data quality of the ambient air measurements that constitute the 2015-2016 NMP dataset. Each monitoring program under the NMP has its own specific Data Quality Objectives (DQOs) which have been established and approved by EPA, consistent with the specific data use needs of the individual monitoring programs. Because the DQOs are program-specific and the ERG laboratory is contracted to perform services for a subset of the overall program participants, attainment of the individual program DQO(s) is not assessed in this report. This section establishes data quality through the assessment of Data Quality Indicators (DQI) in the form of MQOs specific to the program elements conducted by the ERG laboratory. MQOs are established to control and evaluate the various phases of the measurement process (sample collection, preparation, and analysis) to ensure that the total measurement quality meets the overall program data quality objectives. In accordance with ERG's EPA-approved QAPP (ERG, 2015 and ERG, 2016), the following MQOs were assessed: completeness, precision, and accuracy (also called bias).

The quality assessments presented in this section show that the 2015-2016 monitoring data are of a known and high quality, consistent with the intended data use. The overall method-specific completeness was greater than 85 percent for each method. The method precision for collocated and duplicate analyses met the precision MQO of 15 percent Coefficient of Variation (CV) for most methods, with the exceptions of TO-13A for PAHs (which is just outside the 15 percent MQO). The analytical precision for replicate analyses for all methods met the precision MQO of 15 percent CV, with all methods less than 7 percent. Audit samples show that ERG is meeting the accuracy requirements of the NATTS TAD (EPA, 2009a). These data quality indicators are discussed in further detail in the following sections.

24.1 Completeness

Completeness refers to the number of valid samples successfully collected and analyzed compared to the number of total samples scheduled to be collected and analyzed. The MQO for completeness based on the EPA-approved QAPP specifies that at least 85 percent of samples collected at a given monitoring site must be analyzed successfully to be considered sufficient for data trends analysis (ERG, 2015 and ERG, 2016). The MQO of 85 percent completeness was met by 204 of the 215 site-method-year datasets while 11 datasets (seven from 2015 and four from 2016) did not. Completeness statistics are presented and discussed more thoroughly in Section 2.4.

24.2 Method Precision

Precision defines the level of agreement between independent measurements performed according to identical protocols and procedures. *Method precision,* which includes s*ampling and analytical precision,* quantifies random errors associated with collecting ambient air samples in the field, transporting them to the laboratory, and analyzing the samples in the laboratory. Method precision is evaluated by comparing concentrations measured in duplicate or collocated samples. A *duplicate* sample is a sample collected simultaneously with a primary sample through a common inlet probe such that the same air parcel is being sampled. This simultaneous collection is typically achieved by teeing the line from the collection system to two canisters (or other sampling media) and doubling the flow rate applied to achieve integration over the 24-hour collection period. *Collocated* samples are samples collected simultaneously through separate inlet probes, regardless of collection system set-up (i.e., either two separate sampling systems or a single sampling system with multiple inlets). Because the samples are not collected using a common inlet, the system is sampling potentially different air parcels. The overarching difference between the two sample types is whether or not the potential for non-homogeneity of the air parcel is being considered as part of the precision calculation. Duplicate samples provide an indication of "intra-system" variability while collocated samples provide an indication of "inter-system" variability, of which the non-homogeneity of the air parcels sampled factors into the level of precision measured.

During the 2015 and 2016 monitoring efforts, duplicate or collocated samples were collected on at least 10 percent of the scheduled sample days, where possible, as outlined in the EPA-approved QAPP. This provides a minimum of six pairs of either duplicate or collocated samples per site and method per year. For the VOC, SNMOC, and carbonyl compound methods, samples may be duplicate or collocated. For PAHs, metals, and hexavalent chromium, only collocated samples may be collected due to limitations of the sampling media/instrumentation. For each method, these duplicate or collocated samples were then analyzed in replicate at the laboratory (nested approach). *Replicate measurements* are repeated analyses performed on a duplicate or collocated pair of samples and are discussed in greater detail in Section 24.3. Where duplicate or collocated events were not possible at a given monitoring site, replicate analyses were run on individual samples to provide an indication of analytical precision, and are discussed further in Section 24.3.

Method precision is calculated by comparing the concentrations of the duplicates/collocates for each pollutant. The CV for duplicate or collocated samples was calculated for each pollutant and each site. The following approach was employed to estimate how closely the collected and analyzed samples agree with one another:

> ***Coefficient of Variation (CV)*** provides a relative measure of variability. CV is often expressed as a ratio of the standard deviation and the mean, and is used for a single variable. The CV listed below is ideal when comparing paired values, such as a primary concentration and a duplicate concentration, and has been used to evaluate NATTS data for years (EPA, 2017g). A coefficient of variation of 1 percent would indicate that the analytical results could vary slightly due to sampling error, while a variation of 50 percent means that the results are more imprecise.

$$CV = 100 \times \sqrt{\frac{\sum_{i=1}^{n}\left[\frac{(p-r)}{0.5 \times (p+r)}\right]^2}{2n}}$$

Where:

p = the primary result from a duplicate or collocated pair;
r = the secondary result from a duplicate or collocated pair;
n = the number of valid data pairs (the 2 adjusts for the fact that there are two values with error).

CVs were calculated for every pair of duplicate or collocated samples where both measurements were at or above the MDL. Thus, the number of pairs included in the calculations varies significantly from pollutant to pollutant. To make an overall estimate of method precision, program-level average CVs were calculated as follows:

- A site-specific CV was calculated for each pollutant, per the equation above.
- A pollutant-specific average CV was calculated for each method.
- A method-specific average CV was calculated and compared to the precision MQO.

Table 24-1 presents the 2015-2016 NMP method precision for VOCs, SNMOCs, methane, carbonyl compounds, PAHs, metals, and hexavalent chromium, presented as the average CV and expressed as a percentage. CVs exceeding the 15 percent MQO are bolded in the table. Six of the seven analytical methods met the program MQO of 15 percent CV for precision. TO-13A/PAH results did not meet the MQO of 15 percent, although they are just outside the criteria (and are discussed further in the individual method sections). This table also includes the number of pairs that were included in the calculation of the method precision. The total number of pairs including those with concentrations less than the MDL (and with two numerical results) is also included in Table 24-1 for each method to provide an indication of the

effect that excluding those with concentrations less than the MDL has on the population of pairs in the dataset. For some methods, such as TO-11A for carbonyl compounds, the difference is small; for others, such as TO-15 for VOCs, the difference is relatively large.

Table 24-1. Method Precision by Analytical Method

Method/Pollutant Group	Average Coefficient of Variation (%)	Number of Pairs Included in the Calculation	Total Number of Pairs Without the ≥ MDL Exclusion
VOC (TO-15)	9.27	5,596	8,073
SNMOC	12.23	1,694	1,931
Methane	3.70	13	13
Carbonyl Compounds (TO-11A)	6.85	3,418	3,428
PAHs (TO-13A)	**15.27**	583	796
Metals Analysis (Method IO-3.5/FEM)	12.85	3,486	4,101
Hexavalent Chromium (ASTM D7614)	13.48	5	8
MQO	15.00 percent CV		

Bold = CV greater than or equal to 15 percent

Tables 24-2 through 24-8 present method precision for VOCs, SNMOCs, methane, carbonyl compounds, PAHs, metals, and hexavalent chromium, respectively, as the CV per pollutant per site and the average CV per site, per pollutant, and per method. Also included in these tables is the number of duplicate and/or collocated pairs included in the CV calculations. For methods where duplicate or collocated samples are both possible, the type of sample collected at each site is identified and the average CV based on sample type is also provided. CVs exceeding the 15 percent MQO are bolded in each table. The CVs that exceed the program MQO for precision are often driven by relatively low concentrations, even though they are greater than the MDL.

24.2.1 VOC Method Precision

Table 24-2 presents the method precision for all duplicate and collocated VOC samples as the CV per pollutant per site, the average CV per site, the average CV per pollutant, and the overall average CV across the VOCs listed. The duplicate and collocated sample precision results exhibit low- to high-level variability, where the CV ranges from 0 percent (a few pollutants for several sites) to 88.50 percent (dichloromethane for GLKY). The CV for

dichloromethane for GLKY is based on 11 pairs of samples greater than the MDL. For eight of these 11 pairs, the duplicate sample was considerably greater than the primary sample. The number of sites for which a given pollutant has a CV greater than or equal to 15 percent varies, from none (28 pollutants) to 19 (methyl isobutyl ketone). Propylene and chloroethane are the only other pollutants besides methyl isobutyl ketone with a CV greater than or equal to 15 percent for at least 10 sites.

The pollutant-specific average CV, as shown in orange in Table 24-2, ranges from 0 percent (chlorobenzene and 1,1,1-trichloroethane) to 24.19 percent (methyl isobutyl ketone). For both chlorobenzene and 1,1,1-trichloroethane, the precision is based on a single pair of measurements greater than the MDL. The site-specific average CV, as shown in green in Table 24-2, ranges from 6.31 percent (NBNJ) to 16.49 percent (GLKY). GLKY is the only site with a site-specific average CV greater than or equal to15 percent. Note that TVKY collected collocated samples more frequently than the 10 percent requirement, as indicated by the number of collocated sample pairs collected at this site (55). The overall average method precision for VOCs is 9.27 percent, meeting the MQO of 15 percent. Note that the results for acrolein, acetonitrile, acrylonitrile, and carbon disulfide were excluded from the precision calculations due to the issues described in Section 3.2.

Sites at which duplicate samples were collected are highlighted in blue in Table 24-2 while sites at which collocated samples were collected are highlighted in purple. Collocated VOC samples were collected at two of the sites shown in Table 24-2 (PXSS and TVKY); duplicate VOC samples were collected at the remainder of sites. The average CV for sites that collected duplicate samples was calculated and is shown at the end of Table 24-2 in blue while the average CV for sites collecting collocated samples is shown in purple. The average CV for both precision types is less than 15 percent, with less than 1 percent separating them; the variability associated with collocated samples (10.60 percent) is slightly more than the variability associated with duplicate samples (9.91 percent).

Table 24-2. VOC Method Precision: Coefficient of Variation Based on Duplicate and Collocated Samples by Site and Pollutant

Pollutant	BROK	*BTUT*	CHNJ	CSNJ	*DEMI*	ELNJ	*GLKY*
Acetylene	6.56	7.59	**27.32**	3.94	3.97	4.71	4.49
tert-Amyl Methyl Ether	--	--	--	--	--	--	--
Benzene	7.09	12.85	6.60	3.39	**15.30**	3.75	**28.64**
Bromochloromethane	--	--	6.43	--	**18.86**	--	0.00
Bromodichloromethane	--	--	--	--	--	--	--
Bromoform	--	--	--	--	--	--	--
Bromomethane	10.65	3.87	7.54	7.65	10.91	6.43	8.71
1,3-Butadiene	--	**20.74**	8.33	6.46	9.69	7.07	--
Carbon Tetrachloride	11.82	**18.55**	4.73	**33.76**	5.77	**17.56**	5.88
Chlorobenzene	--	--	--	--	--	--	--
Chloroethane	**18.55**	**15.61**	**20.29**	14.46	7.82	**16.29**	12.10
Chloroform	7.33	5.67	4.85	4.37	**21.57**	4.65	12.80
Chloromethane	6.58	6.16	5.36	5.80	4.21	5.29	6.45
Chloroprene	--	--	--	--	--	--	--
Dibromochloromethane	--	--	--	--	--	--	--
1,2-Dibromoethane	--	--	--	--	--	--	--
m-Dichlorobenzene	--	--	--	--	--	--	--
o-Dichlorobenzene	--	--	--	--	--	--	--
p-Dichlorobenzene	--	--	--	--	--	4.29	--
Dichlorodifluoromethane	7.22	8.79	3.10	3.42	3.24	4.58	4.65
1,1-Dichloroethane	--	--	--	--	--	--	--
1,2-Dichloroethane	8.28	9.48	7.68	4.84	4.59	7.57	7.97
1,1-Dichloroethene	--	--	--	--	--	--	--
cis-1,2-Dichloroethylene	--	--	--	--	--	--	--
trans-1,2-Dichloroethylene	**36.94**	--	--	--	--	0.00	--
Dichloromethane	**15.43**	**19.61**	6.15	11.27	6.73	12.42	**88.50**
1,2-Dichloropropane	--	--	--	--	--	--	--
cis-1,3-Dichloropropene	--	--	--	--	--	--	--
trans-1,3-Dichloropropene	--	--	--	--	--	--	--
Dichlorotetrafluoroethane	5.47	3.34	2.67	5.46	3.67	6.13	4.30
Ethyl Acrylate	--	--	--	--	--	--	--

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting duplicate samples; purple shading identifies sites collecting collocated samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-2. VOC Method Precision: Coefficient of Variation Based on Duplicate and Collocated Samples by Site and Pollutant (Continued)

Pollutant	BROK	*BTUT*	CHNJ	CSNJ	*DEMI*	ELNJ	*GLKY*
Ethyl *tert*-Butyl Ether	--	--	3.52	4.56	--	**15.71**	--
Ethylbenzene	8.42	**26.24**	6.80	4.98	6.76	4.08	**15.32**
Hexachloro-1,3-butadiene	--	--	--	--	--	--	--
Methyl Isobutyl Ketone	9.80	11.40	**19.71**	**16.21**	**16.66**	**26.90**	**40.14**
Methyl Methacrylate	--	--	--	--	--	2.18	--
Methyl *tert*-Butyl Ether	--	--	--	--	--	1.96	--
n-Octane	4.70	**20.72**	14.43	6.37	7.52	5.92	14.28
Propylene	**25.44**	**18.04**	**18.80**	**15.79**	8.01	10.94	**26.51**
Styrene	13.63	**32.89**	4.71	**19.63**	12.74	9.27	**49.19**
1,1,2,2-Tetrachloroethane	--	--	--	--	--	--	--
Tetrachloroethylene	--	0.00	1.67	5.36	3.93	4.51	--
Toluene	12.37	**23.47**	4.37	8.82	6.69	2.89	13.29
1,2,4-Trichlorobenzene	--	--	--	--	--	--	--
1,1,1-Trichloroethane	--	--	--	--	--	--	--
1,1,2-Trichloroethane	--	--	--	--	--	--	--
Trichloroethylene	--	0.00	--	2.65	--	0.00	--
Trichlorofluoromethane	6.91	7.48	3.49	3.10	3.33	4.18	3.71
Trichlorotrifluoroethane	6.24	5.92	3.97	2.90	3.47	3.91	4.58
1,2,4-Trimethylbenzene	4.95	7.33	5.99	11.30	7.69	4.62	6.41
1,3,5-Trimethylbenzene	--	--	--	8.61	10.13	4.07	0.00
Vinyl chloride	--	--	7.44	4.28	--	8.32	--
m,p-Xylene	8.92	**28.11**	8.12	3.33	7.22	5.00	**19.39**
o-Xylene	7.73	**26.40**	10.34	6.27	6.97	5.33	**18.43**
Average CV by Site	10.92	13.61	8.31	8.05	8.36	6.89	**16.49**
# of pairs by site	10	9	11	10	12	11	11

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting duplicate samples; purple shading identifies sites collecting collocated samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-2. VOC Method Precision: Coefficient of Variation Based on Duplicate and Collocated Samples by Site and Pollutant (Continued)

Pollutant	*GPCO*	*NBIL*	NBNJ	NRNJ	NROK	OCOK	*PXSS*
Acetylene	4.70	6.41	3.66	6.04	5.07	**16.15**	4.98
tert-Amyl Methyl Ether	--	--	--	--	--	--	--
Benzene	6.32	6.05	5.19	7.78	6.63	7.41	6.60
Bromochloromethane	--	--	--	--	--	--	--
Bromodichloromethane	--	**23.32**	--	--	--	--	--
Bromoform	--	7.69	--	--	--	--	--
Bromomethane	11.14	7.19	4.49	--	--	11.69	11.42
1,3-Butadiene	10.30	7.44	5.22	4.20	5.88	**16.43**	9.57
Carbon Tetrachloride	4.27	6.51	5.65	4.40	5.93	7.27	5.45
Chlorobenzene	--	--	--	--	--	--	--
Chloroethane	**47.54**	**32.31**	2.01	**25.86**	--	10.96	**19.47**
Chloroform	6.91	**19.30**	4.22	8.87	4.76	10.33	5.72
Chloromethane	4.77	8.54	4.80	5.01	6.57	5.31	4.96
Chloroprene	--	--	--	--	--	--	--
Dibromochloromethane	--	**22.16**	--	--	--	--	0.00
1,2-Dibromoethane	--	--	--	--	--	--	--
m-Dichlorobenzene	--	--	--	--	--	--	--
o-Dichlorobenzene	--	--	--	--	--	--	--
p-Dichlorobenzene	--	**22.23**	--	--	9.12	--	10.58
Dichlorodifluoromethane	4.40	5.77	4.93	4.67	5.56	4.54	4.41
1,1-Dichloroethane	--	--	--	--	--	--	--
1,2-Dichloroethane	9.30	12.90	6.12	8.96	7.99	11.01	8.34
1,1-Dichloroethene	--	--	--	--	--	--	--
cis-1,2-Dichloroethylene	--	--	--	--	--	--	--
trans-1,2-Dichloroethylene	4.12	--	--	--	12.85	4.88	0.00
Dichloromethane	10.90	**35.42**	10.30	5.74	6.69	12.27	**35.30**
1,2-Dichloropropane	--	--	--	--	--	--	--
cis-1,3-Dichloropropene	--	--	--	--	--	--	--
trans-1,3-Dichloropropene	--	--	--	--	--	--	--
Dichlorotetrafluoroethane	6.87	4.44	6.23	1.94	--	10.80	3.81
Ethyl Acrylate	--	--	--	--	--	--	--

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting duplicate samples; purple shading identifies sites collecting collocated samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-2. VOC Method Precision: Coefficient of Variation Based on Duplicate and Collocated Samples by Site and Pollutant (Continued)

Pollutant	*GPCO*	*NBIL*	NBNJ	NRNJ	NROK	OCOK	*PXSS*
Ethyl *tert*-Butyl Ether	8.40	4.06	--	9.21	--	--	--
Ethylbenzene	6.54	6.97	4.87	11.79	5.51	4.14	7.71
Hexachloro-1,3-butadiene	--	--	--	--	--	--	--
Methyl Isobutyl Ketone	**30.01**	**15.54**	**22.41**	**30.06**	**23.95**	**27.64**	**37.66**
Methyl Methacrylate	--	--	--	--	--	--	--
Methyl *tert*-Butyl Ether	--	10.88	--	7.19	--	--	--
n-Octane	8.43	14.29	7.68	9.83	9.77	12.79	**18.72**
Propylene	14.00	**19.60**	7.92	**16.89**	11.75	**26.50**	**27.80**
Styrene	**40.65**	5.46	10.79	12.64	6.45	9.50	**22.53**
1,1,2,2-Tetrachloroethane	--	--	--	--	--	--	--
Tetrachloroethylene	10.50	7.20	2.89	4.92	9.43	4.04	8.23
Toluene	4.92	9.04	7.72	5.96	4.72	5.76	13.49
1,2,4-Trichlorobenzene	--	--	--	--	--	--	--
1,1,1-Trichloroethane	--	--	--	--	--	--	--
1,1,2-Trichloroethane	--	--	--	--	--	--	--
Trichloroethylene	--	13.35	--	--	--	9.23	--
Trichlorofluoromethane	4.31	5.74	4.29	4.70	7.29	3.68	4.70
Trichlorotrifluoroethane	4.49	7.55	4.82	5.47	6.78	4.75	4.55
1,2,4-Trimethylbenzene	11.02	9.14	4.34	11.67	6.38	7.95	**15.94**
1,3,5-Trimethylbenzene	6.43	6.01	--	1.69	7.69	4.16	14.74
Vinyl chloride	--	12.29	--	--	--	--	--
m,p-Xylene	12.58	7.43	5.81	10.61	5.30	4.79	7.58
o-Xylene	10.66	7.90	5.10	10.63	5.89	9.16	6.08
Average CV by Site	11.28	11.82	6.31	9.08	7.83	9.75	11.44
# of pairs by site	13	13	5	6	3	12	13

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting duplicate samples; purple shading identifies sites collecting collocated samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-2. VOC Method Precision: Coefficient of Variation Based on Duplicate and Collocated Samples by Site and Pollutant (Continued)

Pollutant	ROIL	*S4MO*	*SEWA*	SPIL	TMOK	TOOK	TROK
Acetylene	5.53	7.27	10.74	7.06	14.39	4.90	6.67
tert-Amyl Methyl Ether	--	--	--	--	--	--	--
Benzene	14.74	9.50	5.09	12.91	7.05	6.19	6.03
Bromochloromethane	--	--	--	--	9.43	--	--
Bromodichloromethane	--	--	--	--	--	--	--
Bromoform	--	--	--	--	--	--	--
Bromomethane	3.89	13.16	**24.40**	7.38	14.91	6.69	4.56
1,3-Butadiene	3.07	12.16	12.56	9.46	12.29	6.74	14.39
Carbon Tetrachloride	8.72	7.80	6.46	**20.72**	5.78	**27.08**	**27.86**
Chlorobenzene	--	--	--	--	--	--	--
Chloroethane	**16.39**	**20.34**	**33.42**	13.72	12.61	**16.86**	**27.10**
Chloroform	6.64	**24.32**	6.79	7.92	7.35	4.28	6.54
Chloromethane	4.92	6.73	6.33	6.26	7.12	4.29	6.88
Chloroprene	--	--	--	--	--	--	--
Dibromochloromethane	--	--	--	--	--	--	--
1,2-Dibromoethane	--	--	--	--	--	--	--
m-Dichlorobenzene	--	--	--	--	--	--	--
o-Dichlorobenzene	--	--	--	--	--	--	--
p-Dichlorobenzene	--	10.12	--	--	2.77	--	--
Dichlorodifluoromethane	5.10	6.01	4.49	5.88	5.77	4.30	6.69
1,1-Dichloroethane	--	--	--	--	--	--	--
1,2-Dichloroethane	7.75	10.75	7.04	8.54	9.24	5.70	7.43
1,1-Dichloroethene	--	2.67	--	0.00	--	--	--
cis-1,2-Dichloroethylene	--	2.18	--	--	--	--	--
trans-1,2-Dichloroethylene	--	--	--	--	--	--	2.18
Dichloromethane	7.58	**36.79**	**42.68**	8.48	13.58	**16.83**	**16.19**
1,2-Dichloropropane	--	--	--	--	--	--	--
cis-1,3-Dichloropropene	--	--	--	--	--	--	--
trans-1,3-Dichloropropene	--	--	--	--	--	--	--
Dichlorotetrafluoroethane	6.07	12.29	7.40	6.36	7.20	5.37	6.56
Ethyl Acrylate	--	--	--	--	--	--	--

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting duplicate samples; purple shading identifies sites collecting collocated samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-2. VOC Method Precision: Coefficient of Variation Based on Duplicate and Collocated Samples by Site and Pollutant (Continued)

Pollutant	ROIL	*S4MO*	*SEWA*	SPIL	TMOK	TOOK	TROK
Ethyl *tert*-Butyl Ether	--	--	--	7.62	--	--	--
Ethylbenzene	4.75	13.63	4.38	12.00	9.55	8.39	6.01
Hexachloro-1,3-butadiene	--	--	--	--	--	--	--
Methyl Isobutyl Ketone	12.92	**21.11**	**37.26**	**21.79**	**26.17**	9.76	**30.08**
Methyl Methacrylate	--	--	--	--	--	--	--
Methyl *tert*-Butyl Ether	--	--	--	11.79	--	--	**26.19**
n-Octane	7.57	14.15	6.64	**17.90**	10.30	5.21	9.52
Propylene	5.27	**17.47**	**25.82**	**16.55**	12.21	13.13	**19.36**
Styrene	--	**16.05**	10.76	14.67	9.49	9.90	10.92
1,1,2,2-Tetrachloroethane	--	--	--	--	--	--	--
Tetrachloroethylene		10.15	6.30	8.60	4.12	2.51	11.40
Toluene	3.85	7.71	5.46	11.10	7.53	4.84	6.13
1,2,4-Trichlorobenzene	--	--	--	--	--	--	--
1,1,1-Trichloroethane	--	--	--	--	--	--	--
1,1,2-Trichloroethane	--	--	--	--	--	--	--
Trichloroethylene	--	9.68	--	13.07	14.01	--	--
Trichlorofluoromethane	4.64	6.24	5.08	5.76	6.01	4.22	5.33
Trichlorotrifluoroethane	4.36	6.78	12.09	6.65	6.07	5.08	5.99
1,2,4-Trimethylbenzene	8.26	**15.90**	5.38	12.18	11.63	8.17	9.12
1,3,5-Trimethylbenzene	--	8.59	--	2.77	--	--	--
Vinyl chloride	--	7.31	--	6.73	--	--	--
m,p-Xylene	6.79	**18.52**	5.22	10.67	9.15	7.13	6.86
o-Xylene	5.31	**17.13**	4.31	10.72	8.80	7.05	8.21
Average CV by Site	7.01	12.42	12.34	10.18	9.90	7.91	11.20
# of pairs by site	4	12	12	10	11	12	12

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting duplicate samples; purple shading identifies sites collecting collocated samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-2. VOC Method Precision: Coefficient of Variation Based on Duplicate and Collocated Samples by Site and Pollutant (Continued)

Pollutant	TVKY	YUOK	# of pairs	Average by Pollutant	Average for Duplicate Pairs	Average for Collocated Pairs
Acetylene	7.83	**20.63**	279	8.29	8.47	6.40
tert-Amyl Methyl Ether	--	--	0	--	--	--
Benzene	7.61	3.92	279	8.55	8.69	7.11
Bromochloromethane	**18.88**	--	7	10.32	8.61	**18.88**
Bromodichloromethane	--	--	9	**23.32**	**23.32**	--
Bromoform	--	--	4	7.69	7.69	--
Bromomethane	**16.26**	10.82	127	9.70	9.27	13.84
1,3-Butadiene	7.96	4.65	157	9.27	9.32	8.76
Carbon Tetrachloride	7.03	5.82	278	11.08	11.54	6.24
Chlorobenzene	0.00	--	1	0.00	--	0.00
Chloroethane	**21.85**	**47.63**	135	**20.60**	**20.59**	**20.66**
Chloroform	11.87	6.57	261	8.85	8.86	8.79
Chloromethane	5.96	**16.89**	279	6.31	6.39	5.46
Chloroprene	8.84	--	1	8.84	--	8.84
Dibromochloromethane	--	--	10	11.08	**22.16**	0.00
1,2-Dibromoethane	--	--	0	--	--	--
m-Dichlorobenzene	--	--	0	--	--	--
o-Dichlorobenzene	--	--	0	--	--	--
p-Dichlorobenzene	--	--	18	9.85	9.71	10.58
Dichlorodifluoromethane	4.55	3.26	279	5.02	5.07	4.48
1,1-Dichloroethane	11.71	--	18	11.71	--	11.71
1,2-Dichloroethane	**20.68**	8.59	238	8.73	8.18	14.51
1,1-Dichloroethene	9.68	--	4	4.12	1.33	9.68
cis-1,2-Dichloroethylene	--	--	1	2.18	2.18	--
trans-1,2-Dichloroethylene	3.82	--	12	8.10	10.16	1.91
Dichloromethane	13.93	13.61	279	**19.41**	**18.91**	**24.61**
1,2-Dichloropropane	6.43	--	1	6.43	--	6.43
cis-1,3-Dichloropropene	--	--	0	--	--	--
trans-1,3-Dichloropropene	--	--	0	--	--	--
Dichlorotetrafluoroethane	9.99	5.24	150	5.98	5.89	6.90
Ethyl Acrylate	--	--	0	--	--	--

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting duplicate samples; purple shading identifies sites collecting collocated samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-2. VOC Method Precision: Coefficient of Variation Based on Duplicate and Collocated Samples by Site and Pollutant (Continued)

Pollutant	TVKY	YUOK	# of pairs	Average by Pollutant	Average for Duplicate Pairs	Average for Collocated Pairs
Ethyl *tert*-Butyl Ether	--	--	22	7.58	7.58	--
Ethylbenzene	10.98	11.60	214	8.76	8.70	9.34
Hexachloro-1,3-butadiene	--	--	0	--	--	--
Methyl Isobutyl Ketone	**31.82**	**37.43**	199	**24.19**	**23.19**	**34.74**
Methyl Methacrylate	--	--	3	3.32	3.32	--
Methyl *tert*-Butyl Ether	--	--	8	11.60	11.60	--
n-Octane	11.96	11.25	205	10.87	10.44	**15.34**
Propylene	**24.63**	**28.86**	279	**17.88**	**17.09**	**26.21**
Styrene	14.09	2.48	115	**15.38**	**15.09**	**18.31**
1,1,2,2-Tetrachloroethane	--	--	0	--	--	--
Tetrachloroethylene	7.91	4.04	110	5.88	5.64	8.07
Toluene	**23.41**	9.02	278	8.81	7.89	**18.45**
1,2,4-Trichlorobenzene	--	--	0	--	--	--
1,1,1-Trichloroethane	0.00	--	1	0.00	--	0.00
1,1,2-Trichloroethane	7.32	--	10	7.32	--	7.32
Trichloroethylene	4.35	--	19	7.37	7.75	4.35
Trichlorofluoromethane	9.15	3.32	279	5.07	4.90	6.93
Trichlorotrifluoroethane	5.01	2.62	279	5.39	5.45	4.78
1,2,4-Trimethylbenzene	9.93	12.80	182	9.05	8.68	12.94
1,3,5-Trimethylbenzene	5.34	4.88	67	6.41	5.92	10.04
Vinyl chloride	12.76	--	42	8.45	7.73	12.76
m,p-Xylene	10.17	9.82	230	9.50	9.56	8.87
o-Xylene	11.24	14.34	227	9.74	9.84	8.66
Average CV by Site	10.97	12.00	5,596	9.27	9.91	10.60
# of pairs by site	55	12				

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting duplicate samples; purple shading identifies sites collecting collocated samples.
BOLD ITALICS = EPA-designated NATTS Site

24.2.2 SNMOC Method Precision

The SNMOC method precision for duplicate and collocated samples is presented in Table 24-3 as the CV per pollutant per site, the average CV per site, the average CV per pollutant, and the overall average CV across the SNMOCs listed. The precision results from duplicate and collocated samples exhibit low- to high-level variability among the pollutants and sites, ranging from a CV of 0 percent (*n*-butane and isobutane for PACO) to 66.84 percent (sum of unknowns for GSCO). Among the 35 pollutants listed in Table 24-3 for which a CV could be calculated for each of the seven sites, 15 pollutants have CVs for all seven sites that are less than 15 percent (e.g., acetylene); conversely, there are two pollutants listed for which all seven CVs are greater than or equal to 15 percent: 1-nonene and sum of unknowns.

The pollutant-specific average CV, as shown in orange in Table 24-3, ranges from 1.98 percent (*n*-butane) to 37.77 percent (*n*-tridecane). The site-specific average CV, as shown in green in Table 24-3, ranges from 7.76 percent (NROK) to 18.08 percent (PACO). The overall average method precision for SNMOCs is 12.23 percent, meeting the MQO of 15 percent. Note that the results for TNMOC were not included in the precision calculations.

Sites at which duplicate samples were collected are highlighted in blue in Table 24-3 while sites at which collocated samples were collected are highlighted in purple. Collocated SNMOC samples were collected at three of the sites shown in Table 24-3 (GSCO, PACO, and RICO); however, relatively few collocated sample pairs were collected at these sites in 2015 and 2016. Duplicate SNMOC samples were collected at the remaining four sites. The average CV for sites that collected duplicate samples was calculated and is shown at the end of Table 24-3 in blue while the average CV for sites collecting collocated samples is shown in purple. The average CV for both precision types is less than 15 percent, with the variability associated with collocated samples (13.62 percent) is slightly more than the variability associated with duplicate samples (11.30 percent).

Table 24-3. SNMOC Method Precision: Coefficient of Variation Based on Collocated and Duplicate Samples by Site and Pollutant

Pollutant	BROK	*BTUT*	GSCO	*NBIL*	NROK
Acetylene	3.55	3.25	0.75	2.68	0.66
Benzene	5.79	6.71	**15.30**	5.53	6.83
1,3-Butadiene	--	3.97	--	--	3.83
n-Butane	0.67	1.16	4.49	5.02	0.75
1-Butene	--	--	--	--	--
cis-2-Butene	--	11.70	13.93	5.40	2.77
trans-2-Butene	**19.85**	11.41	--	--	8.25
Cyclohexane	2.65	4.59	5.19	8.62	1.52
Cyclopentane	1.19	**21.29**	3.41	7.90	1.23
Cyclopentene	--	--	--	--	--
n-Decane	12.46	**15.67**	--	**16.04**	11.07
1-Decene	--	--	--	--	--
m-Diethylbenzene	--	--	--	--	--
p-Diethylbenzene	--	--	--	12.83	--
2,2-Dimethylbutane	13.23	7.08	13.80	4.46	2.80
2,3-Dimethylbutane	1.99	2.61	9.32	4.42	1.08
2,3-Dimethylpentane	6.34	2.52	7.81	7.47	1.61
2,4-Dimethylpentane	13.52	4.94	8.81	9.49	8.09
n-Dodecane	**19.98**	9.76	--	14.95	--
1-Dodecene	--	--	--	--	--
Ethane	0.94	1.73	4.63	11.27	0.49
2-Ethyl-1-butene	--	--	--	--	--
Ethylbenzene	13.23	6.08	5.48	8.93	6.57
Ethylene	**17.78**	5.88	**24.60**	12.24	9.52
m-Ethyltoluene	**17.64**	7.83	**30.87**	14.58	4.30
o-Ethyltoluene	**20.60**	1.69	--	4.65	12.07
p-Ethyltoluene	**17.13**	4.39	**33.43**	12.98	3.31
n-Heptane	7.74	7.24	5.82	**16.41**	1.61
1-Heptene	--	--	--	--	--
n-Hexane	1.56	4.34	12.39	7.49	5.07
1-Hexene	**23.75**	**32.33**	13.55	**34.63**	**20.73**

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided in the final column of the table.
Blue shading identifies sites collecting duplicate samples; purple shading identifies sites collecting collocated samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-3. SNMOC Method Precision: Coefficient of Variation Based on Collocated and Duplicate Samples by Site and Pollutant (Continued)

Pollutant	BROK	*BTUT*	GSCO	*NBIL*	NROK
cis-2-Hexene	--	--	--	--	--
trans-2-Hexene	--	2.53	--	7.91	4.04
Isobutane	0.60	6.18	4.23	6.18	1.03
Isobutylene	--	--	--	--	--
Isopentane	8.60	--	--	3.22	--
Isoprene	9.50	14.14	12.21	**18.10**	5.08
Isopropylbenzene	--	--	--	**17.75**	**19.43**
2-Methyl-1-butene	--	14.58	--	9.08	0.86
3-Methyl-1-butene	--	--	--	--	--
2-Methyl-1-pentene	--	--	--	--	--
4-Methyl-1-pentene	--	--	--	--	--
2-Methyl-2-butene	**17.45**	8.96	**23.00**	11.01	9.65
Methylcyclohexane	4.46	4.43	--	9.71	4.84
Methylcyclopentane	2.97	4.56	4.11	5.34	5.52
2-Methylheptane	**29.11**	5.08	2.72	10.74	5.92
3-Methylheptane	**25.48**	3.14	9.25	10.34	3.69
2-Methylhexane	**18.68**	8.33	**27.22**	**32.87**	**20.65**
3-Methylhexane	13.76	5.28	--	9.96	4.53
2-Methylpentane	4.08	6.41	**24.87**	7.58	5.49
3-Methylpentane	2.32	3.54	4.96	7.63	2.62
n-Nonane	**15.37**	13.81	--	**16.73**	9.45
1-Nonene	**37.21**	**21.58**	**15.21**	**15.69**	**21.94**
n-Octane	**28.54**	11.92	9.17	12.15	2.38
1-Octene	**41.85**	**22.10**	7.26	**43.17**	**22.34**
n-Pentane	2.15	**33.94**	3.95	7.81	5.62
1-Pentene	**34.58**	12.18	4.29	14.12	11.53
cis-2-Pentene	--	6.54	11.22	3.27	3.96
trans-2-Pentene	**21.88**	8.57	13.20	14.76	8.04
a-Pinene	8.81	12.17	8.69	**28.11**	4.74
b-Pinene	--	--	--	--	--
Propane	0.70	2.11	4.84	7.69	0.99

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided in the final column of the table.
Blue shading identifies sites collecting duplicate samples; purple shading identifies sites collecting collocated samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-3. SNMOC Method Precision: Coefficient of Variation Based on Collocated and Duplicate Samples by Site and Pollutant (Continued)

Pollutant	BROK	*BTUT*	GSCO	*NBIL*	NROK
n-Propylbenzene	**44.11**	5.49	--	13.08	**34.25**
Propylene	**26.22**	8.39	**27.85**	**15.73**	9.14
Propyne	--	--	--	--	5.66
Styrene	--	--	--	--	--
Toluene	**17.97**	5.47	6.13	8.42	3.35
n-Tridecane	**49.83**	--	--	**25.70**	--
1-Tridecene	--	--	--	--	--
1,2,3-Trimethylbenzene	--	--	--	**19.05**	**32.57**
1,2,4-Trimethylbenzene	**20.27**	13.33	9.77	**23.95**	**27.99**
1,3,5-Trimethylbenzene	**19.95**	8.72	--	7.21	3.98
2,2,3-Trimethylpentane	--	--	--	7.68	--
2,2,4-Trimethylpentane	5.21	4.59	9.17	9.99	5.54
2,3,4-Trimethylpentane	**20.88**	9.56	**33.77**	**29.84**	14.56
n-Undecane	**18.91**	**18.29**	--	8.91	--
1-Undecene	--	--	--	--	--
m-Xylene/*p*-Xylene	9.06	13.03	4.35	10.39	1.35
o-Xylene	11.81	12.93	12.76	8.53	1.11
SNMOC (Sum of Knowns)	2.88	4.96	4.90	10.00	1.11
Sum of Unknowns	**34.03**	**25.84**	**66.84**	**22.48**	**18.51**
Average CV by Site	**15.11**	9.32	12.88	12.58	7.76
# of pairs by site	10	8	1	13	3

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided in the final column of the table.
Blue shading identifies sites collecting duplicate samples; purple shading identifies sites collecting collocated samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-3. SNMOC Method Precision: Coefficient of Variation Based on Collocated and Duplicate Samples by Site and Pollutant (Continued)

Pollutant	PACO	RICO	# of pairs	Average by Pollutant	Average for Duplicate Pairs	Average for Collocated Pairs
Acetylene	4.33	1.47	39	2.38	2.54	2.18
Benzene	2.05	3.71	38	6.56	6.21	7.02
1,3-Butadiene	--	4.30	5	4.03	3.90	4.30
n-Butane	0.00	1.76	39	1.98	1.90	2.08
1-Butene	--	--	--	--	--	--
cis-2-Butene	--	**16.35**	15	10.03	6.62	**15.14**
trans-2-Butene	--	**24.28**	9	**15.95**	13.17	**24.28**
Cyclohexane	6.68	2.61	38	4.55	4.34	4.83
Cyclopentane	--	5.95	31	6.83	7.90	4.68
Cyclopentene	--	--	--	--	--	--
n-Decane	**29.39**	11.89	26	**16.09**	13.81	**20.64**
1-Decene	--	--	--	--	--	--
m-Diethylbenzene	--	--	--	--	--	--
p-Diethylbenzene	--	--	1	12.83	12.83	--
2,2-Dimethylbutane	**16.75**	11.78	31	9.99	6.89	14.11
2,3-Dimethylbutane	3.72	2.53	39	3.67	2.53	5.19
2,3-Dimethylpentane	11.25	4.15	39	5.88	4.48	7.74
2,4-Dimethylpentane	14.19	5.57	35	9.23	9.01	9.53
n-Dodecane	--	--	11	14.90	14.90	--
1-Dodecene	--	--	--	--	--	--
Ethane	0.49	2.44	39	3.14	3.61	2.52
2-Ethyl-1-butene	--	--	--	--	--	--
Ethylbenzene	**29.71**	10.51	35	11.50	8.70	**15.23**
Ethylene	**18.41**	13.45	39	14.56	11.36	**18.82**
m-Ethyltoluene	--	**21.53**	28	**16.13**	11.09	**26.20**
o-Ethyltoluene	--	**16.36**	12	11.07	9.75	**16.36**
p-Ethyltoluene	--	**29.08**	24	**16.72**	9.45	**31.25**
n-Heptane	5.55	3.47	39	6.83	8.25	4.94
1-Heptene	--	--	--	--	--	--
n-Hexane	0.44	4.56	39	5.12	4.62	5.80
1-Hexene	**51.48**	**47.04**	18	**31.93**	**27.86**	**37.36**

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided in the final column of the table.
Blue shading identifies sites collecting duplicate samples; purple shading identifies sites collecting collocated samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-3. SNMOC Method Precision: Coefficient of Variation Based on Collocated and Duplicate Samples by Site and Pollutant (Continued)

Pollutant	PACO	RICO	# of pairs	Average by Pollutant	Average for Duplicate Pairs	Average for Collocated Pairs
cis-2-Hexene	--	--	--	--	--	--
trans-2-Hexene	--	--	4	4.82	4.82	--
Isobutane	0.00	2.43	39	2.95	3.50	2.22
Isobutylene	--	--	--	--	--	--
Isopentane	--	0.69	5	4.17	5.91	0.69
Isoprene	--	3.68	28	10.45	11.71	7.94
Isopropylbenzene	--	--	2	**18.59**	**18.59**	--
2-Methyl-1-butene	--	12.78	12	9.33	8.17	12.78
3-Methyl-1-butene	--	--	--	--	--	--
2-Methyl-1-pentene	--	--	--	--	--	--
4-Methyl-1-pentene	--	--	--	--	--	--
2-Methyl-2-butene	--	**17.22**	20	14.55	11.77	**20.11**
Methylcyclohexane	5.40	3.58	30	5.40	5.86	4.49
Methylcyclopentane	0.68	4.55	38	3.96	4.60	3.11
2-Methylheptane	7.90	4.82	27	9.47	12.71	5.15
3-Methylheptane	9.34	2.54	29	9.11	10.66	7.04
2-Methylhexane	**43.66**	14.08	38	**23.64**	**20.13**	**28.32**
3-Methylhexane	--	7.70	15	8.25	8.38	7.70
2-Methylpentane	--	14.50	37	10.49	5.89	**19.69**
3-Methylpentane	5.66	3.97	39	4.38	4.03	4.86
n-Nonane	**26.62**	8.80	33	**15.13**	13.84	**17.71**
1-Nonene	**49.75**	**31.20**	21	**27.51**	**24.10**	**32.05**
n-Octane	**18.61**	6.62	37	12.77	13.75	11.47
1-Octene	**50.68**	**36.94**	24	**32.05**	**32.37**	**31.62**
n-Pentane	1.28	1.58	39	8.05	12.38	2.27
1-Pentene	**36.31**	**16.57**	32	**18.51**	**18.10**	**19.05**
cis-2-Pentene	--	9.87	11	6.97	4.59	10.55
trans-2-Pentene	**46.00**	13.19	28	**17.95**	13.31	**24.13**
a-Pinene	--	--	15	12.50	13.46	8.69
b-Pinene	--	--	--	--	--	--
Propane	0.38	2.47	39	2.74	2.87	2.56

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided in the final column of the table.
Blue shading identifies sites collecting duplicate samples; purple shading identifies sites collecting collocated samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-3. SNMOC Method Precision: Coefficient of Variation Based on Collocated and Duplicate Samples by Site and Pollutant (Continued)

Pollutant	PACO	RICO	# of pairs	Average by Pollutant	Average for Duplicate Pairs	Average for Collocated Pairs
n-Propylbenzene	--	**22.27**	11	**23.84**	**24.23**	**22.27**
Propylene	**38.45**	**18.53**	39	**20.62**	14.87	**28.28**
Propyne	--	--	1	5.66	5.66	--
Styrene	--	--	--	--	--	--
Toluene	8.84	3.38	39	7.65	8.80	6.12
n-Tridecane	--	--	4	**37.77**	**37.77**	--
1-Tridecene	--	--	--	--	--	--
1,2,3-Trimethylbenzene	--	**16.44**	9	**22.69**	**25.81**	**16.44**
1,2,4-Trimethylbenzene	**44.05**	**22.03**	31	**23.06**	**21.38**	**25.28**
1,3,5-Trimethylbenzene	--	**20.54**	18	12.08	9.97	**20.54**
2,2,3-Trimethylpentane	--	1.79	2	4.73	7.68	1.79
2,2,4-Trimethylpentane	--	5.65	29	6.69	6.33	7.41
2,3,4-Trimethylpentane	**45.80**	**17.29**	34	**24.53**	**18.71**	**32.29**
n-Undecane	--	--	12	**15.37**	**15.37**	--
1-Undecene	--	--	--	--	--	--
m-Xylene/*p*-Xylene	2.44	5.82	38	6.63	8.46	4.20
o-Xylene	13.80	6.88	38	9.69	8.59	11.15
SNMOC (Sum of Knowns)	4.27	3.48	39	4.52	4.74	4.22
Sum of Unknowns	**32.83**	**36.85**	39	**33.91**	**25.22**	**45.51**
Average CV by Site	**18.08**	11.33	1,694	12.23	11.30	13.62
# of pairs by site	1	3				

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided in the final column of the table.
Blue shading identifies sites collecting duplicate samples; purple shading identifies sites collecting collocated samples.
BOLD ITALICS = EPA-designated NATTS Site

24.2.3 Methane Method Precision

Table 24-4 presents the method precision for all duplicate methane samples as the CV per site and the overall average CV for the method. All samples evaluated in this section are duplicate samples. Only two NMP sites sampled methane during the 2015 and/or 2016 monitoring efforts, BROK and NROK. The site-specific CV ranges from 2.99 percent for BROK to 4.41 percent for NROK; note that these CVs are based on 10 duplicate sample pairs for BROK and three pairs for NROK. The overall average method precision for methane is 3.70 percent, as

shown in orange in Table 24-4, which is considerably less than the MQO of 15 percent CV for method precision.

Table 24-4. Methane Method Precision: Coefficient of Variation Based on Duplicate Samples by Site and Pollutant

Pollutant	BROK	NROK	# of pairs	Average by Pollutant
Methane	2.99	4.41	13	3.70
# of pairs	10	3		

Bold = CV greater than or equal to 15 percent
Orange shading indicates the pollutant-specific average CV.
BOLD ITALICS = EPA-designated NATTS Site

24.2.4 Carbonyl Compound Method Precision

Table 24-5 presents the method precision for duplicate and collocated carbonyl compound samples as the CV per pollutant per site, the average CV per site, the average CV per pollutant, and the overall average CV across the carbonyl compounds listed. The duplicate and collocated sample results exhibit low- to mid-level variability, ranging from a CV of 0.45 percent (butyraldehyde for NBNJ) to 41.86 percent (2-butanone for SYFL). SYFL's 2-butanone CV was also the highest CV among the sites sampling carbonyl compounds for the 2014 NMP report. The number of sites for which a given pollutant has a CV greater than or equal to 15 percent varies from none (propionaldehyde) to four (2-butanone and valeraldehyde).

The pollutant-specific average CV, as shown in orange in Table 24-5, ranges from 3.98 percent (formaldehyde) to 8.75 percent (2-butanone). The site-specific average CV, as shown in green in Table 24-5, ranges from 2.29 percent (NROK) to 21.19 percent (NRNJ). Three sites collecting duplicate or collocated carbonyl compound samples have site-specific average CVs greater than or equal to 15 percent (DEMI, NRNJ, and SYFL). The NBNJ site was moved at the end of 2015 and relocated to NRNJ at the beginning of 2016. The relatively high CVs shown for NRNJ result primarily from one particularly imprecise pair of samples collected on July 17, 2016, compared to the higher CVs shown for DEMI and SYFL, where disagreement among the sample pairs was more common. The overall average method precision is 6.85 percent for carbonyl compounds.

Sites at which duplicate samples were collected are highlighted in blue in Table 24-5 while sites at which collocated samples were collected are highlighted in purple. Collocated carbonyl compound samples were collected at three sites shown in Table 24-5 (DEMI, INDEM, and PXSS); duplicate samples were collected at the remaining sites. The average CV for sites

that collected duplicate samples was calculated and is shown at the end of Table 24-5 in blue while the average CV for sites collecting collocated samples is shown in purple. The average CV for both precision types is less than 15 percent, with the variability associated with collocated samples (10.72 percent) greater than the variability associated with duplicate samples (6.38 percent).

Table 24-5. Carbonyl Compound Method Precision: Coefficient of Variation Based on Duplicate and Collocated Samples by Site and Pollutant

Pollutant	AZFL	BROK	*BTUT*	CHNJ	CSNJ	*DEMI*	ELNJ	*GLKY*
Acetaldehyde	3.67	**18.05**	5.32	4.34	2.20	**16.59**	1.98	1.23
Acetone	5.99	**23.81**	6.49	6.95	6.72	8.20	5.16	4.46
Benzaldehyde	7.84	6.14	7.42	6.39	5.15	**17.05**	5.25	6.99
2-Butanone	13.42	7.68	4.54	6.49	5.47	8.17	5.20	5.32
Butyraldehyde	7.27	3.71	5.85	4.33	2.41	**26.07**	2.50	4.06
Crotonaldehyde	5.56	8.02	6.58	4.91	3.32	14.85	4.66	2.79
2,5-Dimethylbenzaldehyde	--	--	--	--	--	--	--	--
Formaldehyde	7.68	0.91	5.12	4.73	2.35	11.94	2.06	1.30
Hexaldehyde	8.38	4.74	6.27	6.11	6.58	**26.46**	2.57	5.01
Isovaleraldehyde	--	--	--	--	--	--	--	--
Propionaldehyde	5.72	8.46	5.14	2.71	3.53	7.32	2.67	1.25
Tolualdehydes	9.03	5.33	6.66	7.44	7.87	**16.44**	7.60	4.92
Valeraldehyde	5.98	6.28	5.82	5.81	5.38	**16.66**	4.11	8.01
Average CV by Site	7.32	8.47	5.93	5.47	4.64	**15.43**	3.98	4.12
# of pairs by site	13	10	11	8	11	12	12	12

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting duplicate samples; purple shading identifies sites collecting collocated samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-5. Carbonyl Compound Method Precision: Coefficient of Variation Based on Duplicate and Collocated Samples by Site and Pollutant (Continued)

Pollutant	*GPCO*	INDEM	*NBIL*	NBNJ	NRNJ	NROK	OCOK	ORFL
Acetaldehyde	3.95	5.86	2.90	1.18	2.90	0.84	1.51	4.50
Acetone	10.77	10.91	6.70	2.55	**21.62**	0.67	2.81	9.46
Benzaldehyde	**19.54**	12.21	6.17	5.05	**31.41**	3.48	7.86	7.89
2-Butanone	8.20	8.43	7.37	4.22	**36.82**	2.15	3.08	**16.86**
Butyraldehyde	3.82	6.99	3.61	0.45	**28.23**	1.66	2.70	7.63
Crotonaldehyde	7.72	8.24	4.74	2.78	**31.69**	1.49	1.93	**16.41**
2,5-Dimethylbenzaldehyde	--	--	--	--	--	--	--	--
Formaldehyde	3.39	5.49	3.37	1.39	2.92	1.30	1.93	3.36
Hexaldehyde	3.87	5.72	7.28	5.99	**30.89**	2.13	3.48	5.83
Isovaleraldehyde	--	--	--	--	--	--	--	--
Propionaldehyde	5.24	10.57	4.36	3.34	3.40	3.09	3.50	6.57
Tolualdehydes	9.60	6.89	9.74	7.63	**17.70**	5.89	5.31	13.77
Valeraldehyde	2.79	12.19	5.72	5.91	**25.55**	2.52	4.26	8.03
Average CV by Site	7.17	8.50	5.63	3.68	**21.19**	2.29	3.49	9.12
# of pairs by site	10	18	16	5	6	4	12	11

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting duplicate samples; purple shading identifies sites collecting collocated samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-5. Carbonyl Compound Method Precision: Coefficient of Variation Based on Duplicate and Collocated Samples by Site and Pollutant (Continued)

Pollutant	*PXSS*	ROIL	*S4MO*	*SEWA*	*SKFL*	SPIL	*SYFL*	TMOK
Acetaldehyde	4.18	4.20	1.92	6.39	2.85	3.15	7.24	0.98
Acetone	6.86	3.84	4.27	3.77	11.07	2.35	14.05	3.35
Benzaldehyde	5.53	4.40	6.37	11.82	6.48	6.77	11.59	6.41
2-Butanone	2.90	5.94	3.32	2.31	**23.66**	3.34	**41.86**	4.16
Butyraldehyde	6.98	6.83	3.07	3.98	6.76	3.65	**21.86**	2.77
Crotonaldehyde	4.92	5.41	4.26	6.88	11.87	3.20	**33.07**	2.78
2,5-Dimethylbenzaldehyde	--	--	--	--	--	--	--	--
Formaldehyde	12.05	3.61	1.83	5.05	3.05	4.50	12.55	1.16
Hexaldehyde	10.44	5.02	3.06	6.18	5.39	7.67	**15.82**	5.92
Isovaleraldehyde	--	--	--	--	--	--	--	--
Propionaldehyde	5.14	4.79	3.70	5.96	5.67	5.44	14.53	1.74
Tolualdehydes	11.60	4.37	7.40	7.05	8.10	8.27	**16.08**	4.42
Valeraldehyde	**19.85**	7.07	6.35	7.26	11.47	6.92	**17.58**	4.87
Average CV by Site	8.22	5.04	4.14	6.06	8.76	5.03	**18.75**	3.50
# of pairs by site	15	5	12	12	11	10	11	12

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting duplicate samples; purple shading identifies sites collecting collocated samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-5. Carbonyl Compound Method Precision: Coefficient of Variation Based on Duplicate and Collocated Samples by Site and Pollutant (Continued)

Pollutant	TOOK	TROK	WPIN	YUOK	# of pairs	Average by Pollutant	Average for Duplicate Pairs	Average for Collocated Pairs
Acetaldehyde	0.95	1.62	3.90	0.86	315	4.12	3.55	8.87
Acetone	3.31	1.97	3.82	1.70	315	6.91	6.71	8.66
Benzaldehyde	6.43	6.30	5.38	5.21	307	8.52	8.15	11.60
2-Butanone	1.93	2.87	6.75	2.59	313	8.75	9.02	6.50
Butyraldehyde	1.78	1.96	6.33	4.15	315	6.48	5.66	13.35
Crotonaldehyde	1.67	3.36	5.87	3.01	313	7.57	7.36	9.34
2,5-Dimethylbenzaldehyde	--	--	--	--	--	--	--	--
Formaldehyde	1.53	1.41	4.42	1.06	315	3.98	3.28	9.83
Hexaldehyde	4.16	3.88	6.23	3.73	312	7.46	6.65	14.21
Isovaleraldehyde	--	--	--	--	--	--	--	--
Propionaldehyde	3.55	3.70	4.40	1.56	312	4.90	4.56	7.68
Tolualdehydes	7.13	6.87	9.73	6.87	289	8.56	8.19	11.64
Valeraldehyde	4.13	4.97	5.97	4.42	312	8.07	7.09	**16.23**
Average CV by Site	3.32	3.54	5.71	3.20	3,418	6.85	6.38	10.72
# of pairs by site	12	12	20	12				

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting duplicate samples; purple shading identifies sites collecting collocated samples.
BOLD ITALICS = EPA-designated NATTS Site

24.2.5 PAH Method Precision

The method precision results for collocated PAH samples are shown in Table 24-6 as the CV per pollutant per site, the average CV per site, the average CV per pollutant, and the overall average CV across the PAHs listed. All samples evaluated in this section are collocated samples. Ownership, maintenance, and use of collocated systems were the responsibility of the participating agency for sites sampling PAHs. Thus, collocated samples were not collected at most PAH sites because few had collocated collection systems. The method precision presented for PAHs is based on data from three sites (DEMI, RUCA, and SEWA) and a total of 42 sample pairs. The results from collocated samples exhibit low- to mid-level variability, ranging from a CV of 0.57 percent (benzo(a)pyrene for SEWA) to 45.08 percent (anthracene for RUCA). The overall average method precision is 15.27 percent, which is just greater than the MQO of 15 percent CV.

The pollutant-specific average CV, as shown in orange in Table 24-6, ranges from 6.41 percent (benzo(a)anthracene) to 27.15 percent (anthracene). The site-specific average CVs, as shown in green in Table 24-6, range from 4.93 percent for SEWA to 18.19 percent for DEMI to 21.54 percent for RUCA. None of the CVs for SEWA are greater than or equal to 15 percent while many PAHs are greater than or equal to 15 percent for DEMI (11 pollutants) and RUCA (16 pollutants).

Table 24-6. PAH Method Precision: Coefficient of Variation Based on Collocated Samples by Site and Pollutant

Pollutant	*DEMI*	*RUCA*	*SEWA*	# of pairs	Average by Pollutant
Acenaphthene	5.03	**36.54**	4.15	38	**15.24**
Acenaphthylene	6.97	**25.24**	7.11	19	13.11
Anthracene	**29.93**	**45.08**	6.42	25	**27.15**
Benzo(a)anthracene	8.91	9.26	1.07	17	6.41
Benzo(a)pyrene	9.06	**17.38**	0.57	14	9.01
Benzo(b)fluoranthene	**36.60**	**34.38**	4.31	23	**25.10**
Benzo(e)pyrene	**34.61**	**32.07**	1.32	22	**22.67**
Benzo(g,h,i)perylene	**30.52**	**23.73**	3.59	23	**19.28**
Benzo(k)fluoranthene	**15.06**	**15.06**	--	9	**15.06**
Chrysene	**37.81**	**29.37**	5.91	28	**24.36**
Coronene	**23.81**	12.61	9.16	31	**15.19**
Cyclopenta(c,d)pyrene	4.31	11.53	8.63	14	8.16
Dibenz(a,h)anthracene	4.29	**15.15**	--	9	9.72
Fluoranthene	**30.96**	**16.80**	4.81	42	**17.52**
Fluorene	6.33	**19.98**	4.48	35	10.27
9-Fluorenone	9.08	11.48	3.98	42	8.18
Indeno(1,2,3-c,d)pyrene	**34.09**	**33.37**	1.73	21	**23.06**
Naphthalene	4.55	13.19	5.23	42	7.65
Perylene	14.07	**16.77**	--	10	**15.42**
Phenanthrene	**16.41**	13.62	4.44	42	11.49
Pyrene	**31.56**	**18.51**	5.49	42	**18.52**
Retene	6.27	**22.81**	11.21	35	13.43
Average CV by Site	**18.19**	**21.54**	4.93	583	**15.27**
# of pairs by site	10	21	11		

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided in the final column of the table.
BOLD ITALICS = EPA-designated NATTS Site

24.2.6 Metals Method Precision

The method precision for all collocated metals samples are presented in Table 24-7 as the CV per pollutant per site, the average CV per site, the average CV per pollutant, and the overall average CV across the metals listed. All samples evaluated in this section are collocated samples. The results from collocated samples exhibit low- to high-level variability, ranging from a CV of 2.75 percent (arsenic for ASKY-M) to 56.57 percent (mercury for BOMA). The number of sites for which a given pollutant has a CV greater than or equal to 15 percent varies from none (antimony and manganese) to four (cadmium). Note that BOMA, GLKY, S4MO, and TOOK collected collocated samples more frequently than the 10 percent requirement.

The pollutant-specific average CV, as shown in orange in Table 24-7, ranges from 7.74 percent (antimony) to 24.22 percent (mercury); four of the 11 metals have an average CV greater than 15 percent. The site-specific average CV, as shown in green in Table 24-7, ranges from 8.41 percent (TOOK) to 20.32 percent (BOMA). Two sites (BOMA and BTUT) have site-specific average CVs greater than or equal to 15 percent. The overall average method precision for metals is 12.85 percent.

Table 24-7. Metals Method Precision: Coefficient of Variation Based on Collocated Samples by Site and Pollutant

Pollutant	ASKY-M	***BOMA***	***BTUT***	***GLKY***	***GPCO***
Antimony	3.10	9.39	8.95	13.92	8.79
Arsenic	2.75	**20.12**	9.71	13.10	4.25
Beryllium	12.01	**22.04**	**17.83**	**24.54**	14.74
Cadmium	**27.14**	**18.19**	8.99	13.10	**15.40**
Chromium	9.58	2.82	**15.78**	--	--
Cobalt	6.16	12.67	11.43	9.75	**43.84**
Lead	2.79	11.23	**26.46**	11.60	4.06
Manganese	4.67	11.84	14.47	7.95	5.72
Mercury	**23.68**	**56.57**	**34.71**	11.77	14.99
Nickel	11.17	**42.69**	9.21	**23.65**	10.86
Selenium	6.38	**15.95**	**17.24**	7.49	7.90
Average CV by Site	9.95	**20.32**	**15.89**	13.69	13.05
# of pairs by site	11	58	12	46	12

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided in the final column of the table.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-7. Metals Method Precision: Coefficient of Variation Based on Collocated Samples by Site and Pollutant (Continued)

Pollutant	*S4MO*	TOOK	# of pairs	Average by Pollutant
Antimony	4.11	5.92	373	7.74
Arsenic	7.02	4.12	369	8.73
Beryllium	14.26	8.40	331	**16.26**
Cadmium	5.99	**21.54**	373	**15.76**
Chromium	13.32	6.83	147	9.67
Cobalt	7.69	7.48	301	14.14
Lead	4.71	6.14	374	9.57
Manganese	4.42	5.63	374	7.81
Mercury	13.81	14.01	152	**24.22**
Nickel	**18.57**	7.82	342	**17.71**
Selenium	8.32	4.62	350	9.70
Average CV by Site	9.29	8.41	3,486	12.85
# of pairs by site	114	121		

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided in the final column of the table.
BOLD ITALICS = EPA-designated NATTS Site

24.2.7 Hexavalent Chromium Method Precision

Table 24-8 presents the method precision results from collocated hexavalent chromium samples as the CV per site and the overall average CV for the method. All samples evaluated in this section are collocated samples. Hexavalent chromium was sampled at RIVA throughout 2015 and through the end of June in 2016. The overall average method precision for hexavalent chromium is 13.48 percent, as shown in orange in Table 24-8, which is less than the MQO of 15 percent CV for method precision. Note that the precision calculations are based on five collocated pairs.

Table 24-8. Hexavalent Chromium Method Precision: Coefficient of Variation Based on Collocated Samples by Site

Pollutant	*RIVA*	# of pairs	Average by Pollutant
Hexavalent Chromium	13.48	5	13.48

Bold = CV greater than or equal to 15 percent
Orange shading indicates the average CV for this method.
BOLD ITALICS = EPA-designated NATTS Site

24.3 Analytical Precision

Analytical precision is a measurement of random errors associated with the process of analyzing environmental samples. These errors may result from various factors, including random "noise" inherent to analytical instruments. Laboratories can evaluate the analytical precision of ambient air samples by comparing concentrations measured during multiple analyses of a single sample (i.e., replicate samples). Replicate analyses were run on duplicate or collocated samples collected during the program years. CVs were calculated for every replicate analysis run on duplicate or collocated samples collected during the program year. In addition, replicate analyses were also run on select individual samples, which can provide an indication of analytical precision for monitoring sites unable to collect duplicate or collocated samples (i.e., collection systems "unequipped" to collect duplicate or collocated samples). Individual samples with replicate analyses were also factored into the CV calculations for analytical precision. Only results at or above the MDL were used in these calculations, similar to the calculation of method precision discussed in Section 24.2.

Table 24-9 presents the 2015-2016 NMP analytical precision for VOCs, SNMOCs, methane, carbonyl compounds, PAHs, metals, and hexavalent chromium, presented as average CV and expressed as a percentage. The average CV for each method met the program MQO of 15 percent for precision. The analytical precision for all methods is less than 7 percent. This table also includes the number of pairs that were included in the calculation of the analytical precision. The total number of pairs including those with concentrations less than the MDL (and two numerical results) is also included in Table 24-9 to provide an indication of the effect that excluding those with concentrations less than the MDL has on the population of pairs in the dataset.

Table 24-9. Analytical Precision by Analytical Method

Method/Pollutant Group	Average Coefficient of Variation (%)	Number of Pairs Included in the Calculation	Total Number of Pairs Without the ≥ MDL Exclusion
VOCs (TO-15)	5.64	12,345	18,350
SNMOCs	4.78	6,098	6,682
Methane	2.91	40	40
Carbonyl Compounds (TO-11A)	2.48	7,244	7,263
PAHs (TO-13A)	1.79	4,097	5,727
Metals Analysis (Method IO-3.5/FEM)	4.79	8,477	9,827
Hexavalent Chromium (ASTM D7641)	6.53	13	14
MQO	15.00 percent CV		

Bold = CV greater than or equal to 15 percent

Tables 24-10 through 24-16 present analytical precision for VOCs, SNMOCs, methane, carbonyl compounds, PAHs, metals, and hexavalent chromium, respectively, as the CV per pollutant per site and the average CV per pollutant, per site, and per method. Pollutants exceeding the 15 percent MQO for CV are bolded in each table. In Tables 24-10 through 24-16, the number of pairs in comparison to the respective tables listed for duplicate or collocated analyses in Tables 24-2 through 24-8 is higher, the reason for which is two-fold. One reason is because each primary and duplicate (or collocated) sample produces a replicate analysis. The second reason is due to replicate analyses run on individual samples. This is also the reason the number of sites provided in Tables 24-10 through 24-16 is higher than Tables 24-2 through 24-8 (with the exception of methane and hexavalent chromium). The replicate analyses of duplicate, collocated, and individual samples indicate that the analytical precision level is within the program MQOs.

24.3.1 VOC Analytical Precision

Table 24-10 presents analytical precision results from replicate analyses of duplicate, collocated, and select individual VOC samples as the CV per pollutant per site, the average CV per site, the average CV per pollutant, and the overall average CV across the VOCs listed. Sites at which duplicate samples were collected are highlighted in blue in Table 24-10, sites at which collocated samples were collected are highlighted in purple, and sites for which analytical replicates were run only on individual field samples are highlighted in brown. Collocated VOC

samples were collected at two of the sites shown in Table 24-10 (PXSS, and TVKY); replicates were run on only individual VOC samples for six sites, and duplicate VOC samples were collected at the remaining of sites. However, analytical replicates could be run on any of the sites collecting VOC samples (e.g., replicates could be run on individual VOC samples as well as collocated samples for additional precision information for PXSS).

The analytical precision results from replicate analyses show that, for most of the pollutants, the VOC analytical precision is within 15 percent. The CV ranged from 0 percent (several pollutants and several sites) to 20.20 percent (vinyl chloride for YUOK). The number of sites for which a given pollutant has a CV greater than or equal to 15 percent varies from none (48 pollutants) to two (vinyl chloride).

The pollutant-specific average CV, as shown in orange in Table 24-10, ranges from 2.01 percent (chlorobenzene) to 8.83 percent (ethyl *tert*-butyl ether). The site-specific average CV, as shown in green in Table 24-10, ranges from 3.44 percent (RFCO) to 8.70 percent (YUOK). The overall average analytical precision is 5.65 percent. Note that the results for acrolein, acetonitrile, acrylonitrile, and carbon disulfide were excluded from the precision calculations due to the issues described in Section 3.2.

Table 24-10. VOC Analytical Precision: Coefficient of Variation Based on Replicate Analyses by Site and Pollutant

Pollutant	ASKY	ATKY	BLKY	BROK	*BTUT*	CHNJ	CSNJ	*DEMI*
Acetylene	4.47	5.75	4.82	5.53	7.35	4.41	3.60	3.88
tert-Amyl Methyl Ether	--	--	--	--	--	--	--	--
Benzene	7.52	3.87	6.47	5.23	6.39	4.47	2.53	7.56
Bromochloromethane	3.82	4.04	3.82	--	--	7.35	4.29	7.26
Bromodichloromethane	--	--	--	--	--	--	--	--
Bromoform	--	--	--	--	--	--	--	--
Bromomethane	9.40	7.64	8.32	6.96	5.75	4.49	6.75	5.44
1,3-Butadiene	6.07	9.92	14.51	0.00	7.49	13.36	5.31	6.30
Carbon Tetrachloride	5.02	4.04	5.22	6.99	6.80	4.57	2.87	5.04
Chlorobenzene	--	--	--	--	--	--	--	--
Chloroethane	**15.34**	6.69	5.76	10.11	4.83	6.48	4.45	6.29
Chloroform	6.72	5.64	6.46	9.93	7.01	5.85	3.94	6.92
Chloromethane	4.13	4.45	4.16	5.54	6.95	3.91	2.73	4.36
Chloroprene	--	--	--	--	--	--	--	--
Dibromochloromethane	--	--	--	--	--	--	--	--
1,2-Dibromoethane	--	--	--	--	--	--	--	--
m-Dichlorobenzene	--	--	--	--	--	--	--	--
o-Dichlorobenzene	--	--	--	--	--	--	--	--
p-Dichlorobenzene	--	--	--	--	--	--	--	--
Dichlorodifluoromethane	3.46	4.28	4.24	5.98	7.12	3.99	2.99	4.05
1,1-Dichloroethane	--	0.00	--	--	--	--	--	--
1,2-Dichloroethane	9.50	7.64	5.79	7.11	7.79	8.50	5.73	5.83
1,1-Dichloroethene	--	--	--	--	--	--	--	--
cis-1,2-Dichloroethylene	--	--	--	--	--	--	--	--
trans-1,2-Dichloroethylene	--	--	--	7.37	--	--	5.66	--
Dichloromethane	3.78	4.57	2.94	6.44	6.70	3.50	4.69	5.36
1,2-Dichloropropane	--	--	--	--	--	--	--	--
cis-1,3-Dichloropropene	--	--	--	--	--	--	--	--
trans-1,3-Dichloropropene	--	--	--	--	--	--	--	--
Dichlorotetrafluoroethane	6.01	7.49	5.02	5.79	6.48	4.37	7.22	3.88
Ethyl Acrylate	--	--	--	--	--	--	--	--
Ethyl *tert*-Butyl Ether	--	--	--	--	--	8.61	6.25	--

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting duplicate samples; purple shading identifies sites collecting collocated samples; and brown shading identifies sites for which replicate analyses were run on only individual samples.
***BOLD ITALICS* = EPA-designated NATTS Site**

Table 24-10. VOC Analytical Precision: Coefficient of Variation Based on Replicate Analyses by Site and Pollutant (Continued)

Pollutant	ASKY	ATKY	BLKY	BROK	*BTUT*	CHNJ	CSNJ	*DEMI*
Ethylbenzene	13.05	8.68	8.74	4.65	7.24	8.60	3.54	5.88
Hexachloro-1,3-butadiene	--	--	--	--	--	--	--	--
Methyl Isobutyl Ketone	10.04	6.06	10.87	6.65	9.65	8.47	5.31	6.44
Methyl Methacrylate	--	3.45	--	--	--	--	7.02	--
Methyl *tert*-Butyl Ether	1.89	--	--	--	--	0.00	--	--
n-Octane	**15.40**	3.87	7.04	4.69	7.21	9.48	3.62	8.04
Propylene	6.01	4.20	5.08	5.05	7.53	4.15	3.39	3.82
Styrene	9.41	3.79	3.84	4.79	8.27	7.17	4.58	7.25
1,1,2,2-Tetrachloroethane	--	--	--	--	--	--	--	--
Tetrachloroethylene	12.18	--	--	--	6.48	6.08	4.76	4.49
Toluene	6.55	4.13	8.03	3.39	5.49	4.87	2.80	6.31
1,2,4-Trichlorobenzene	--	--	--	--	--	--	--	--
1,1,1-Trichloroethane	--	0.00	--	--	--	--	--	--
1,1,2-Trichloroethane	--	1.17	--	--	--	--	--	--
Trichloroethylene	--	12.30	--	--	9.83	--	2.38	--
Trichlorofluoromethane	3.22	4.14	4.00	5.20	8.36	3.70	2.81	3.62
Trichlorotrifluoroethane	3.89	4.39	4.13	5.56	7.50	4.28	3.85	4.10
1,2,4-Trimethylbenzene	11.58	4.87	11.21	4.91	7.89	5.08	5.20	6.37
1,3,5-Trimethylbenzene	9.66	5.92	2.77	--	--	4.88	6.52	6.76
Vinyl chloride	--	4.21	5.61	**15.79**	--	0.00	7.18	--
m,p-Xylene	9.38	7.71	7.54	4.34	6.97	9.58	4.15	6.24
o-Xylene	10.93	7.46	6.75	5.10	6.44	9.99	4.35	5.97
Average CV by Site	7.72	5.24	6.28	6.12	7.18	5.87	4.53	5.67
# of pairs by site	13	11	12	20	16	23	20	24

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting duplicate samples; purple shading identifies sites collecting collocated samples; and brown shading identifies sites for which replicate analyses were run on only individual samples.
***BOLD ITALICS* = EPA-designated NATTS Site**

Table 24-10. VOC Analytical Precision: Coefficient of Variation Based on Replicate Analyses by Site and Pollutant (Continued)

Pollutant	ELNJ	*GLKY*	*GPCO*	LEKY	*NBIL*	NBNJ	NRNJ	NROK
Acetylene	3.60	4.16	5.02	3.53	6.07	5.52	3.42	2.02
tert-Amyl Methyl Ether	--	--	--	--	--	--	--	--
Benzene	5.76	4.97	5.36	6.41	3.88	4.29	4.87	3.85
Bromochloromethane	--	11.11	--	--	--	--	8.99	--
Bromodichloromethane	--	--	--	--	5.56	--	--	--
Bromoform	--	--	--	--	4.53	--	--	--
Bromomethane	4.25	10.50	7.19	8.70	7.62	7.52	0.00	--
1,3-Butadiene	5.11	10.00	9.26	7.95	7.64	7.91	4.78	2.43
Carbon Tetrachloride	4.80	3.70	4.68	3.97	5.16	5.07	5.06	3.43
Chlorobenzene	--	--	--	--	--	--	--	--
Chloroethane	7.04	8.25	7.86	6.65	5.47	7.04	6.36	0.00
Chloroform	7.25	8.92	8.86	5.59	4.40	5.44	6.67	4.45
Chloromethane	4.75	4.22	4.16	3.93	5.05	4.72	3.82	3.02
Chloroprene	--	--	--	--	--	--	--	--
Dibromochloromethane	--	--	--	--	5.09	--	--	--
1,2-Dibromoethane	--	--	--	--	--	--	--	--
m-Dichlorobenzene	--	--	--	--	--	--	--	--
o-Dichlorobenzene	--	--	--	--	--	--	--	--
p-Dichlorobenzene	3.25	--	--	5.24	5.91	--	--	6.45
Dichlorodifluoromethane	4.49	3.79	3.99	3.24	4.85	4.44	4.12	2.83
1,1-Dichloroethane	--	--	--	--	--	--	--	--
1,2-Dichloroethane	12.28	10.97	8.88	7.91	7.98	5.40	8.48	5.04
1,1-Dichloroethene	--	--	--	--	--	--	--	--
cis-1,2-Dichloroethylene	--	--	--	--	--	--	--	--
trans-1,2-Dichloroethylene	3.23	--	2.18	0.00	--	--	--	4.05
Dichloromethane	6.12	7.09	5.29	4.75	4.66	5.70	4.39	5.42
1,2-Dichloropropane	--	--	--	--	--	--	--	--
cis-1,3-Dichloropropene	--	--	--	--	--	--	--	--
trans-1,3-Dichloropropene	--	--	--	--	--	--	--	--
Dichlorotetrafluoroethane	7.34	9.03	5.85	2.86	7.14	6.05	1.37	--
Ethyl Acrylate	--	--	--	--	--	--	--	--
Ethyl *tert*-Butyl Ether	11.61	--	7.97	--	3.46	--	8.61	--

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting duplicate samples; purple shading identifies sites collecting collocated samples; and brown shading identifies sites for which replicate analyses were run on only individual samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-10. VOC Analytical Precision: Coefficient of Variation Based on Replicate Analyses by Site and Pollutant (Continued)

Pollutant	ELNJ	*GLKY*	*GPCO*	LEKY	*NBIL*	NBNJ	NRNJ	NROK
Ethylbenzene	4.50	11.54	6.46	8.94	4.73	4.59	7.13	7.00
Hexachloro-1,3-butadiene	--	--	--	--	--	--	--	--
Methyl Isobutyl Ketone	8.65	6.75	8.46	7.50	8.23	7.37	8.87	4.15
Methyl Methacrylate	1.54	--	--	--	--	--	--	--
Methyl *tert*-Butyl Ether	5.23	--	--	4.33	4.00	--	7.49	--
n-Octane	6.81	6.92	8.12	11.19	8.87	4.01	9.34	5.53
Propylene	3.90	4.15	5.82	7.56	5.38	4.20	3.46	2.59
Styrene	6.42	12.39	4.47	7.44	8.06	9.01	10.48	8.28
1,1,2,2-Tetrachloroethane	--	--	--	--	--	--	--	--
Tetrachloroethylene	5.59	--	8.53	3.14	3.94	3.68	6.78	5.44
Toluene	3.78	5.49	4.09	6.28	3.52	3.18	5.10	6.07
1,2,4-Trichlorobenzene	--	--	--	--	--	--	--	--
1,1,1-Trichloroethane	--	--	--	--	--	--	--	--
1,1,2-Trichloroethane	--	--	--	--	--	--	--	--
Trichloroethylene	0.00	--	--	--	9.82	--	--	--
Trichlorofluoromethane	4.27	3.50	4.15	2.40	4.42	4.29	4.05	2.40
Trichlorotrifluoroethane	5.27	5.38	5.08	3.61	5.82	3.88	5.39	3.51
1,2,4-Trimethylbenzene	5.81	10.02	6.39	6.57	5.23	3.41	11.55	6.92
1,3,5-Trimethylbenzene	6.59	4.16	7.62	2.48	5.41	--	5.28	8.74
Vinyl chloride	4.80	--	--	7.44	9.99	--	--	--
m,p-Xylene	4.16	13.74	5.51	7.01	4.36	4.09	7.13	6.79
o-Xylene	4.11	13.91	6.00	7.08	5.15	2.79	7.36	6.73
Average CV by Site	5.38	7.79	6.19	5.65	5.80	5.15	6.08	4.69
# of pairs by site	22	22	26	9	27	10	12	6

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting duplicate samples; purple shading identifies sites collecting collocated samples; and brown shading identifies sites for which replicate analyses were run on only individual samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-10. VOC Analytical Precision: Coefficient of Variation Based on Replicate Analyses by Site and Pollutant (Continued)

Pollutant	OCOK	*PXSS*	RFCO	ROIL	*S4MO*	*SEWA*	SPAZ	SPIL
Acetylene	6.28	5.16	1.13	5.85	6.45	4.65	4.26	5.70
tert-Amyl Methyl Ether	--	--	--	--	--	--	--	--
Benzene	4.18	5.63	2.78	6.01	7.38	5.73	6.33	7.00
Bromochloromethane	--	--	--	--	--	--	7.89	--
Bromodichloromethane	--	--	--	--	--	--	--	--
Bromoform	--	--	--	--	--	--	--	--
Bromomethane	13.98	12.27	6.97	6.82	12.93	6.08	4.18	8.31
1,3-Butadiene	7.74	11.27	2.78	8.42	9.86	10.95	5.63	6.63
Carbon Tetrachloride	4.53	4.30	2.61	5.72	8.16	5.15	4.49	7.24
Chlorobenzene	--	--	0.00	--	--	--	--	--
Chloroethane	8.62	5.53	2.05	6.87	8.16	8.21	4.32	6.26
Chloroform	7.11	4.81	6.63	8.78	6.75	5.68	5.56	8.74
Chloromethane	5.67	4.59	2.06	5.33	5.69	4.17	4.37	5.54
Chloroprene	--	--	--	--	--	--	--	--
Dibromochloromethane	--	6.67	--	--	--	--	--	--
1,2-Dibromoethane	--	--	--	--	--	--	--	--
m-Dichlorobenzene	--	--	--	--	--	--	--	--
o-Dichlorobenzene	--	--	--	--	--	--	--	--
p-Dichlorobenzene	--	5.45	--	--	6.15	--	6.36	--
Dichlorodifluoromethane	5.40	4.90	2.00	5.24	5.62	4.31	4.24	5.56
1,1-Dichloroethane	--	--	--	--	--	--	--	--
1,2-Dichloroethane	6.07	8.49	6.16	7.18	9.58	6.58	6.70	12.95
1,1-Dichloroethene	0.00	--	--	--	3.96	--	--	5.26
cis-1,2-Dichloroethylene	--	--	--	--	4.22	--	--	--
trans-1,2-Dichloroethylene	7.14	4.72	--	--	--	8.32	--	--
Dichloromethane	5.07	5.70	4.24	6.06	4.56	6.93	4.04	6.26
1,2-Dichloropropane	--	--	--	--	--	--	--	--
cis-1,3-Dichloropropene	--	--	--	--	--	--	--	--
trans-1,3-Dichloropropene	--	--	--	--	--	--	--	--
Dichlorotetrafluoroethane	9.11	6.97	3.36	8.51	10.35	4.50	2.67	7.37
Ethyl Acrylate	--	--	--	--	--	--	--	--
Ethyl *tert*-Butyl Ether	--	--	--	--	--	--	--	9.47

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting duplicate samples; purple shading identifies sites collecting collocated samples; and brown shading identifies sites for which replicate analyses were run on only individual samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-10. VOC Analytical Precision: Coefficient of Variation Based on Replicate Analyses by Site and Pollutant (Continued)

Pollutant	OCOK	*PXSS*	RFCO	ROIL	*S4MO*	*SEWA*	SPAZ	SPIL
Ethylbenzene	5.13	7.29	2.43	7.18	9.74	5.40	6.39	11.18
Hexachloro-1,3-butadiene	--	--	--	--	--	--	--	--
Methyl Isobutyl Ketone	6.69	6.04	8.80	10.00	8.52	6.45	9.70	10.15
Methyl Methacrylate	--	--	--	--	--	--	--	--
Methyl *tert*-Butyl Ether	--	--	--	--	--	--	--	4.35
n-Octane	5.98	10.47	6.41	6.25	12.69	3.84	5.47	12.67
Propylene	6.25	4.80	1.77	5.26	5.10	4.51	8.75	5.93
Styrene	8.05	9.67	1.64	7.86	13.97	4.08	8.05	14.47
1,1,2,2-Tetrachloroethane	--	--	--	--	--	--	--	--
Tetrachloroethylene	4.04	5.49	4.04	--	9.02	3.69	4.47	6.66
Toluene	4.65	5.02	2.19	4.80	4.95	4.93	6.19	6.28
1,2,4-Trichlorobenzene	--	--	--	--	--	--	--	--
1,1,1-Trichloroethane	--	--	--	--	0.00	--	--	--
1,1,2-Trichloroethane	--	--	--	--	--	--	--	--
Trichloroethylene	6.66	--	--	--	6.32	--	3.34	9.24
Trichlorofluoromethane	5.18	5.02	2.94	5.12	5.58	4.44	4.28	5.51
Trichlorotrifluoroethane	5.04	4.51	3.01	4.79	5.90	6.35	4.87	6.45
1,2,4-Trimethylbenzene	6.23	7.66	2.10	9.25	12.12	5.42	8.15	10.85
1,3,5-Trimethylbenzene	1.54	11.66	--	--	7.87	0.00	5.00	12.81
Vinyl chloride	--	--	6.33	--	7.21	--	--	6.73
m,p-Xylene	5.83	6.71	1.59	6.57	7.70	5.46	6.49	9.65
o-Xylene	6.00	7.56	3.45	5.97	9.10	5.32	6.41	10.41
Average CV by Site	6.01	6.73	3.44	6.69	7.60	5.43	5.66	8.19
# of pairs by site	24	27	3	9	24	24	15	21

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting duplicate samples; purple shading identifies sites collecting collocated samples; and brown shading identifies sites for which replicate analyses were run on only individual samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-10. VOC Analytical Precision: Coefficient of Variation Based on Replicate Analyses by Site and Pollutant (Continued)

Pollutant	TMOK	TOOK	TROK	TVKY	YUOK	# of pairs	Average by Pollutant
Acetylene	4.90	5.70	3.91	5.70	5.89	623	4.78
tert-Amyl Methyl Ether	--	--	--	--	--	0	--
Benzene	5.14	4.52	2.88	5.13	6.39	623	5.26
Bromochloromethane	7.51	--	--	7.59	--	21	6.70
Bromodichloromethane	--	--	--	--	--	19	5.56
Bromoform	--	--	--	--	--	9	4.53
Bromomethane	5.46	6.59	8.82	8.78	6.98	293	7.45
1,3-Butadiene	8.74	6.48	9.11	6.09	9.44	374	7.63
Carbon Tetrachloride	4.81	4.09	3.15	5.99	5.63	622	4.91
Chlorobenzene	--	--	--	4.02	--	4	2.01
Chloroethane	6.41	6.72	7.22	6.16	6.97	333	6.62
Chloroform	6.21	6.10	5.33	7.50	13.35	590	6.78
Chloromethane	5.52	4.49	3.84	3.39	5.63	623	4.49
Chloroprene	--	--	--	4.31	--	2	4.31
Dibromochloromethane	--	--	--	--	--	21	5.88
1,2-Dibromoethane	--	--	--	--	--	0	--
m-Dichlorobenzene	--	--	--	--	--	0	--
o-Dichlorobenzene	--	--	--	--	--	0	--
p-Dichlorobenzene	5.80	--	2.57	--	--	51	5.24
Dichlorodifluoromethane	4.04	4.32	5.32	3.26	5.63	623	4.40
1,1-Dichloroethane	--	--	--	5.09	--	38	2.55
1,2-Dichloroethane	7.80	6.00	4.81	6.22	13.76	538	7.83
1,1-Dichloroethene	--	--	--	6.70	**15.71**	15	6.33
cis-1,2-Dichloroethylene	--	--	--	--	--	2	4.22
trans-1,2-Dichloroethylene	--	--	0.00	2.70	**15.22**	34	5.05
Dichloromethane	5.01	5.83	4.22	7.50	7.29	623	5.31
1,2-Dichloropropane	--	--	--	3.45	--	1	3.45
cis-1,3-Dichloropropene	--	--	--	--	--	0	--
trans-1,3-Dichloropropene	--	--	--	--	--	0	--
Dichlorotetrafluoroethane	6.75	7.46	6.86	7.90	6.55	335	6.22
Ethyl Acrylate	--	--	--	--	--	0	--
Ethyl *tert*-Butyl Ether	--	12.86	4.88	--	14.63	49	8.83

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting duplicate samples; purple shading identifies sites collecting collocated samples; and brown shading identifies sites for which replicate analyses were run on only individual samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-10. VOC Analytical Precision: Coefficient of Variation Based on Replicate Analyses by Site and Pollutant (Continued)

Pollutant	TMOK	TOOK	TROK	TVKY	YUOK	# of pairs	Average by Pollutant
Ethylbenzene	7.60	7.26	4.31	10.97	8.78	503	7.21
Hexachloro-1,3-butadiene	--	--	--	--	--	0	--
Methyl Isobutyl Ketone	8.21	4.96	4.83	8.96	10.09	493	7.82
Methyl Methacrylate	4.42	--	--	--	8.32	10	4.95
Methyl *tert*-Butyl Ether	--	--	5.30	0.00	--	22	3.62
n-Octane	6.58	4.61	3.62	10.56	7.57	476	7.48
Propylene	4.71	4.66	3.28	6.93	6.17	623	4.98
Styrene	5.30	9.52	8.50	8.87	5.21	288	7.62
1,1,2,2-Tetrachloroethane	--	--	--	--	--	0	--
Tetrachloroethylene	3.64	4.52	4.89	6.67	9.46	254	5.74
Toluene	4.22	3.46	3.31	5.42	6.70	622	4.87
1,2,4-Trichlorobenzene	--	--	--	--	--	0	--
1,1,1-Trichloroethane	--	--	--	7.03	--	4	2.34
1,1,2-Trichloroethane	--	--	--	8.03	--	21	4.60
Trichloroethylene	**16.81**	--	--	6.16	--	43	7.53
Trichlorofluoromethane	4.37	4.09	3.17	3.36	5.92	623	4.26
Trichlorotrifluoroethane	4.34	4.77	3.36	3.96	6.51	623	4.81
1,2,4-Trimethylbenzene	7.57	6.70	6.00	7.36	8.31	431	7.27
1,3,5-Trimethylbenzene	8.36	6.96	7.19	3.16	2.40	163	5.99
Vinyl chloride	--	--	--	4.65	**20.20**	104	7.70
m,p-Xylene	6.06	5.79	4.44	9.41	8.03	529	6.64
o-Xylene	6.81	6.09	5.04	10.03	8.38	519	6.92
Average CV by Site	6.31	5.94	4.83	6.19	8.70	12,817	5.65
# of pairs by site	22	24	24	109	24		

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting duplicate samples; purple shading identifies sites collecting collocated samples; and brown shading identifies sites for which replicate analyses were run on only individual samples.
BOLD ITALICS = EPA-designated NATTS Site

24.3.2 SNMOC Analytical Precision

Table 24-11 presents analytical precision results from replicate analyses of duplicate, collocated, and select individual samples as the CV per pollutant per site, the average CV per site, the average CV per pollutant, and the overall average CV across the SNMOCs listed. Sites at which duplicate samples were collected (4) are highlighted in blue in Table 24-11, sites at which collocated samples were collected (2) are highlighted in purple, and sites for which analytical replicates were run only on individual field samples (4) are highlighted in brown. However, analytical replicates could be run on any of the sites collecting SNMOC samples (e.g., replicates could be run on individual SNMOC samples as well as collocated samples for additional precision information for PACO).

The CVs range from 0 percent (1,2,3-trimethylbenzene for BMCO) to 23.06 percent (*n*-tridecane for NBIL). Three SNMOCs have a site-specific CV greater than or equal to 15 percent. The pollutant-specific average CV, as shown in orange in Table 24-11, ranges from 0.44 percent (1-dodecene) to 13.28 percent (*n*-tridecane). Note that the average CV for 1-dodecene is based on a single individual sample and its replicate analysis. None of the SNMOCs shown in Table 24-11 have an average CV greater than or equal to 15 percent. The site-specific average CV, as shown in green in Table 24-11, varies by less than 2 percent, ranging from 3.76 percent (NROK) to 5.57 percent (RFCO). The overall average analytical precision is 4.78 percent. Note that the results for TNMOC were not included in the precision calculations.

Table 24-11. SNMOC Analytical Precision: Coefficient of Variation Based on Replicate Analyses by Site and Pollutant

Pollutant	BMCO	BRCO	BROK	*BTUT*	GSCO	*NBIL*
Acetylene	1.58	3.42	3.42	2.48	2.35	2.49
Benzene	6.80	2.97	3.40	3.98	3.52	4.77
1,3-Butadiene	--	--	--	4.89	7.36	--
n-Butane	0.45	0.99	0.92	1.38	1.28	1.85
1-Butene	--	--	--	--	--	--
cis-2-Butene	9.53	**15.36**	--	6.27	3.73	2.21
trans-2-Butene	3.66	2.66	6.44	6.59	3.45	
Cyclohexane	2.49	1.62	1.54	3.08	3.11	6.45
Cyclopentane	1.78	2.97	1.55	2.18	2.80	5.54
Cyclopentene	--	5.20	--	--	--	--
n-Decane	7.45	3.84	5.41	4.85	3.92	6.03
1-Decene	--	--	--	--	--	--
m-Diethylbenzene	--	--	--	--	--	--
p-Diethylbenzene	--	--	--	--	--	6.78
2,2-Dimethylbutane	2.45	4.02	3.32	9.42	7.09	5.83
2,3-Dimethylbutane	1.15	2.42	2.49	2.53	4.68	4.56
2,3-Dimethylpentane	4.72	5.61	3.20	2.70	6.82	6.55
2,4-Dimethylpentane	6.16	7.21	4.63	4.33	6.73	5.91
n-Dodecane	--	1.72	6.30	11.60	10.54	8.68
1-Dodecene	--	--	--	--	--	--
Ethane	0.57	0.51	1.00	0.68	0.75	0.97
2-Ethyl-1-butene	--	--	--	--	--	--
Ethylbenzene	7.06	6.29	6.90	5.37	6.77	7.86
Ethylene	1.65	1.18	1.50	1.02	1.04	1.08
m-Ethyltoluene	7.79	7.68	3.96	5.00	4.52	4.45
o-Ethyltoluene	--	--	7.90	7.86	13.69	7.09
p-Ethyltoluene	11.72	7.33	7.40	8.78	9.33	7.26
n-Heptane	4.86	2.83	2.16	3.90	3.66	4.15
1-Heptene	--	8.14	--	--	--	--
n-Hexane	3.49	2.25	2.45	2.36	2.07	3.25
1-Hexene	8.09	8.24	7.73	7.35	3.12	10.30

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting duplicate samples; purple shading identifies sites collecting collocated samples; and brown shading identifies sites for which replicate analyses were run on only individual samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-11. SNMOC Analytical Precision: Coefficient of Variation Based on Replicate Analyses by Site and Pollutant (Continued)

Pollutant	BMCO	BRCO	BROK	*BTUT*	GSCO	*NBIL*
cis-2-Hexene	--	--	--	--	--	--
trans-2-Hexene	--	--	--	9.24	1.00	7.50
Isobutane	0.43	0.78	0.85	0.63	0.71	1.23
Isobutylene	--	--	--	--	--	--
Isopentane	0.55	0.75	2.31	0.46	0.98	0.77
Isoprene	5.29	8.73	4.78	4.82	5.57	4.26
Isopropylbenzene	--	--	12.29	--	--	1.27
2-Methyl-1-butene	--	--	--	8.86	7.13	5.06
3-Methyl-1-butene	--	--	--	--	--	--
2-Methyl-1-pentene	--	--	--	--	--	--
4-Methyl-1-pentene	--	--	--	--	--	--
2-Methyl-2-butene	--	2.30	7.91	5.99	5.44	2.45
Methylcyclohexane	3.20	2.27	1.40	2.83	2.01	4.86
Methylcyclopentane	2.37	1.54	1.86	4.92	2.54	2.97
2-Methylheptane	5.56	6.58	3.41	4.72	7.66	6.53
3-Methylheptane	5.06	7.21	3.51	6.36	5.18	5.90
2-Methylhexane	3.93	4.74	2.54	3.13	3.72	4.54
3-Methylhexane	4.43	2.17	4.66	5.16	0.58	2.96
2-Methylpentane	1.90	1.91	3.03	3.45	2.69	3.71
3-Methylpentane	2.02	2.40	2.11	4.57	4.75	2.31
n-Nonane	5.06	8.18	4.79	3.45	4.04	4.47
1-Nonene	8.82	7.12	7.63	7.16	5.82	5.32
n-Octane	4.52	3.58	4.01	3.75	4.59	4.56
1-Octene	6.15	7.91	5.15	5.24	6.42	9.07
n-Pentane	1.26	1.03	1.45	1.58	1.19	1.92
1-Pentene	4.27	6.19	4.64	3.79	4.81	4.56
cis-2-Pentene	--	--	--	5.39	6.99	8.12
trans-2-Pentene	8.44	9.80	4.59	4.32	6.44	5.65
a-Pinene	2.29	9.03	4.85	4.16	4.84	6.05
b-Pinene	--	--	--	--	--	--
Propane	0.58	0.61	0.87	0.83	0.70	0.92

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting duplicate samples; purple shading identifies sites collecting collocated samples; and brown shading identifies sites for which replicate analyses were run on only individual samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-11. SNMOC Analytical Precision: Coefficient of Variation Based on Replicate Analyses by Site and Pollutant (Continued)

Pollutant	BMCO	BRCO	BROK	*BTUT*	GSCO	*NBIL*
n-Propylbenzene	--	3.02	2.08	6.57	12.22	3.35
Propylene	1.33	2.41	2.21	1.49	2.77	2.97
Propyne	--	--	--	--	--	--
Styrene	--	0.66	--	--	--	--
Toluene	5.78	3.79	3.12	2.59	2.86	3.46
n-Tridecane	--	--	9.59	--	--	**23.06**
1-Tridecene	--	--	--	--	--	--
1,2,3-Trimethylbenzene	0.00	6.63	7.91	5.12	7.62	7.66
1,2,4-Trimethylbenzene	6.82	6.15	4.82	5.38	6.67	4.23
1,3,5-Trimethylbenzene	10.38	5.79	4.71	8.08	0.63	6.50
2,2,3-Trimethylpentane	--	7.04	--	--	--	6.53
2,2,4-Trimethylpentane	--	--	8.94	4.72	5.62	4.93
2,3,4-Trimethylpentane	4.07	11.47	12.07	10.84	6.40	5.63
n-Undecane	--	--	6.13	6.83	0.23	4.49
1-Undecene	--	--	--	--	--	--
m-Xylene/*p*-Xylene	5.51	5.67	3.51	3.45	5.61	4.94
o-Xylene	6.74	9.06	5.10	5.26	5.54	5.51
SNMOC (Sum of Knowns)	1.35	0.58	0.75	1.43	0.73	1.81
Sum of Unknowns	2.31	2.34	3.86	3.22	3.42	4.55
Average CV by Site	4.28	4.69	4.33	4.64	4.47	5.01
# of pairs by site	5	14	20	16	10	26

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting duplicate samples; purple shading identifies sites collecting collocated samples; and brown shading identifies sites for which replicate analyses were run on only individual samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-11. SNMOC Analytical Precision: Coefficient of Variation Based on Replicate Analyses by Site and Pollutant (Continued)

Pollutant	NROK	PACO	RFCO	RICO	# of pairs	Average by Pollutant
Acetylene	1.66	2.85	3.19	1.99	139	2.54
Benzene	3.95	3.85	4.23	5.67	136	4.32
1,3-Butadiene	2.39	--	13.62	3.84	17	6.42
n-Butane	0.93	1.39	2.07	1.58	139	1.28
1-Butene	--	--	--	--	--	--
cis-2-Butene	4.77	4.64	8.34	5.75	66	6.73
trans-2-Butene	4.40	6.45	5.93	4.88	48	4.94
Cyclohexane	3.22	1.71	5.72	1.89	137	3.08
Cyclopentane	1.95	2.82	3.74	2.44	113	2.78
Cyclopentene	0.36	--	--	4.72	4	3.43
n-Decane	7.08	4.30	8.11	6.64	81	5.76
1-Decene	--	--	--	--	--	--
m-Diethylbenzene	--	--	--	--	--	--
p-Diethylbenzene	--	--	--	2.33	3	4.55
2,2-Dimethylbutane	1.35	3.57	3.66	4.69	110	4.54
2,3-Dimethylbutane	1.06	1.56	4.97	2.60	139	2.80
2,3-Dimethylpentane	1.55	4.72	6.32	3.39	136	4.56
2,4-Dimethylpentane	4.45	6.97	6.50	5.14	124	5.80
n-Dodecane	--	6.06	10.32	6.24	35	7.68
1-Dodecene	--	--	0.44	--	1	0.44
Ethane	0.73	0.78	0.72	1.17	139	0.79
2-Ethyl-1-butene	--	--	--	--	--	--
Ethylbenzene	4.18	7.80	6.55	8.22	122	6.70
Ethylene	2.00	1.04	1.12	1.70	139	1.33
m-Ethyltoluene	4.73	6.53	5.13	6.05	102	5.58
o-Ethyltoluene	8.05	3.87	6.55	5.30	41	7.54
p-Ethyltoluene	7.51	7.47	9.93	4.25	84	8.10
n-Heptane	2.90	2.78	5.00	4.19	139	3.64
1-Heptene	--	--	5.76	--	4	6.95
n-Hexane	3.68	3.44	5.04	3.93	139	3.20
1-Hexene	7.36	7.43	6.63	6.68	78	7.29

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting duplicate samples; purple shading identifies sites collecting collocated samples; and brown shading identifies sites for which replicate analyses were run on only individual samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-11. SNMOC Analytical Precision: Coefficient of Variation Based on Replicate Analyses by Site and Pollutant (Continued)

Pollutant	NROK	PACO	RFCO	RICO	# of pairs	Average by Pollutant
cis-2-Hexene	--	--	12.37	--	1	12.37
trans-2-Hexene	9.65	6.39	11.50	5.39	13	7.24
Isobutane	1.28	0.83	1.40	1.35	139	0.95
Isobutylene	--	--	--	--	--	--
Isopentane	--	0.54	0.70	1.65	22	0.97
Isoprene	4.01	5.93	2.85	6.06	99	5.23
Isopropylbenzene	6.69	6.28	4.85	--	9	6.27
2-Methyl-1-butene	4.50	6.22	6.73	6.76	50	7.10
3-Methyl-1-butene	--	--	--	--	--	--
2-Methyl-1-pentene	--	--	--	--	1	1.27
4-Methyl-1-pentene	--	--	--	--	--	--
2-Methyl-2-butene	6.44	4.06	7.55	4.45	72	5.18
Methylcyclohexane	1.99	1.86	7.73	1.90	117	3.01
Methylcyclopentane	3.10	3.21	3.22	1.85	137	2.76
2-Methylheptane	1.01	3.68	4.13	6.45	101	4.97
3-Methylheptane	3.10	4.12	3.41	4.33	114	4.82
2-Methylhexane	1.90	2.37	7.38	3.01	137	3.72
3-Methylhexane	4.90	6.27	--	4.63	47	3.97
2-Methylpentane	1.82	1.96	2.25	2.08	135	2.48
3-Methylpentane	4.59	3.62	7.47	3.14	139	3.70
n-Nonane	4.99	2.58	5.79	3.11	107	4.65
1-Nonene	8.33	5.98	5.81	6.52	80	6.85
n-Octane	1.61	1.90	6.29	3.67	133	3.85
1-Octene	8.09	6.09	4.97	9.91	89	6.90
n-Pentane	1.15	1.41	3.55	1.61	139	1.62
1-Pentene	3.99	4.75	4.06	5.61	116	4.67
cis-2-Pentene	5.15	7.19	11.46	7.20	38	7.36
trans-2-Pentene	6.91	5.54	5.69	6.36	105	6.37
a-Pinene	1.46	3.91	7.30	7.70	51	5.16
b-Pinene	--	--	--	--	--	--
Propane	0.47	0.77	1.00	1.30	139	0.81

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting duplicate samples; purple shading identifies sites collecting collocated samples; and brown shading identifies sites for which replicate analyses were run on only individual samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-11. SNMOC Analytical Precision: Coefficient of Variation Based on Replicate Analyses by Site and Pollutant (Continued)

Pollutant	NROK	PACO	RFCO	RICO	# of pairs	Average by Pollutant
n-Propylbenzene	6.81	3.08	4.67	7.14	44	5.44
Propylene	0.59	1.57	1.48	1.70	139	1.85
Propyne	4.55	--	--	--	2	4.55
Styrene	--	3.06	0.97	9.27	10	3.49
Toluene	3.30	2.56	3.49	4.77	139	3.57
n-Tridecane	--	--	7.20	--	9	13.28
1-Tridecene	--	--	--	--	--	--
1,2,3-Trimethylbenzene	4.53	8.73	6.99	10.76	34	6.59
1,2,4-Trimethylbenzene	2.96	6.82	5.10	4.48	111	5.34
1,3,5-Trimethylbenzene	5.46	6.35	11.92	9.35	71	6.92
2,2,3-Trimethylpentane	--	2.98	7.36	6.19	10	6.02
2,2,4-Trimethylpentane	3.06	2.80	6.46	4.52	89	5.13
2,3,4-Trimethylpentane	6.86	**17.78**	8.68	6.67	106	9.05
n-Undecane	--	3.95	8.56	9.79	34	5.71
1-Undecene	--	--	4.37	--	2	4.37
m-Xylene/*p*-Xylene	3.36	2.82	5.44	5.52	138	4.58
o-Xylene	2.42	6.29	7.07	4.49	137	5.75
SNMOC (Sum of Knowns)	1.08	11.34	1.13	1.98	139	2.22
Sum of Unknowns	3.18	3.53	3.46	4.38	139	3.43
Average CV by Site	3.76	4.41	5.57	4.72	6,098	4.78
# of pairs by site	6	14	12	16		

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting duplicate samples; purple shading identifies sites collecting collocated samples; and brown shading identifies sites for which replicate analyses were run on only individual samples.
BOLD ITALICS = EPA-designated NATTS Site

24.3.3 Methane Analytical Precision

Table 24-12 presents the analytical precision results from replicate analysis of duplicate and select individual methane samples as the CV per site and the overall average CV for the method. As discussed in Section 24.2.3, only BROK and NROK sampled methane during the 2015 and/or 2016 monitoring efforts. The site-specific CV ranges from 2.74 percent for BROK to 3.09 percent for NROK. The overall average method precision for methane is 2.91 percent, as shown in orange in Table 24-12, which is considerably less than the MQO of 15 percent CV.

Table 24-12. Methane Analytical Precision: Coefficient of Variation Based on Replicate Analyses by Site and Pollutant

Pollutant	BROK	NROK	# of pairs	Average by Pollutant
Methane	2.74	3.09	40	2.91
# of pairs	28	12		

Bold = CV greater than or equal to 15 percent
Orange shading indicates the pollutant-specific average CV.
BOLD ITALICS = EPA-designated NATTS Site

24.3.4 Carbonyl Compound Analytical Precision

Table 24-13 presents the analytical precision results from replicate analyses of duplicate, collocated, and select individual carbonyl compound samples as the CV per pollutant per site, the average CV per site, the average CV per pollutant, and the overall average CV for the carbonyl compounds listed. Sites at which duplicate samples were collected are highlighted in blue in Table 24-13, sites at which collocated samples were collected are highlighted in purple, and sites for which replicates were run on only individual samples are highlighted in brown. Collocated carbonyl compound samples were collected at three of the sites shown in Table 24-13 (DEMI, INDEM, and PXSS); replicates were run on only individual field samples for five sites, and duplicate samples were collected at the remaining sites. Analytical replicates were typically run on duplicate or collocated sample pairs, although replicates could be analyzed for any sample type.

The overall average CV is 2.48 percent, which is well within the program MQO of 15 percent CV. The analytical precision results from replicate analyses range from 0 percent (several pollutants at different sites) to 9.07 percent (valeraldehyde for GSCO), indicating that every pollutant-site combination has a CV less than 15 percent.

The pollutant-specific average CV, as shown in orange in Table 24-13, ranges from 0.75 percent (acetone) to 4.36 percent (tolualdehydes), indicating that all of the pollutant-specific average CVs are less than 5 percent. The site-specific average CV, as shown in green in Table 24-13, ranges from 1.83 percent (NROK) to 3.53 percent (RICO), indicating that all of the site-specific average CVs are also less than 5 percent.

Table 24-13. Carbonyl Compound Analytical Precision: Coefficient of Variation Based on Replicate Analyses by Site and Pollutant

Pollutant	AZFL	BMCO	BRCO	BROK	*BTUT*	CHNJ	CSNJ	*DEMI*
Acetaldehyde	1.61	1.19	2.32	0.46	0.59	0.36	0.47	0.97
Acetone	1.50	0.31	0.38	1.56	0.46	0.55	0.73	0.55
Benzaldehyde	4.29	3.14	5.33	3.70	3.30	4.50	2.46	4.08
2-Butanone	3.24	1.55	2.95	1.55	2.15	1.92	1.79	2.45
Butyraldehyde	3.94	4.93	3.38	2.28	2.26	2.86	1.56	2.33
Crotonaldehyde	2.54	3.80	4.26	1.68	3.15	0.87	2.22	2.32
2,5-Dimethylbenzaldehyde	--	--	--	--	--	--	--	--
Formaldehyde	0.83	0.51	1.51	1.01	0.54	0.55	0.76	0.86
Hexaldehyde	3.78	5.44	5.25	3.63	2.14	3.49	2.90	3.11
Isovaleraldehyde	--	--	--	--	--	--	--	--
Propionaldehyde	2.69	4.62	3.31	2.60	1.48	2.34	2.01	1.58
Tolualdehydes	4.19	5.66	3.89	4.39	3.69	4.71	3.66	4.19
Valeraldehyde	3.88	4.30	0.00	3.02	3.91	4.58	2.65	2.84
Average CV by Site	2.95	3.22	2.96	2.35	2.15	2.43	1.93	2.30
# of pairs by site	26	5	9	20	22	16	22	21

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting duplicate samples; purple shading identifies sites collecting collocated samples; and brown shading identifies sites for which replicate analyses were run on only individual samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-13. Carbonyl Compound Analytical Precision: Coefficient of Variation Based on Replicate Analyses by Site and Pollutant (Continued)

Pollutant	ELNJ	*GLKY*	*GPCO*	GSCO	INDEM	*NBIL*	NBNJ
Acetaldehyde	0.44	1.08	0.66	0.96	1.43	0.68	0.55
Acetone	0.51	0.87	0.59	0.31	0.70	0.51	0.62
Benzaldehyde	3.10	4.83	3.66	2.44	4.52	4.65	3.15
2-Butanone	1.28	2.06	1.29	1.28	2.75	1.68	1.94
Butyraldehyde	1.34	2.80	2.27	0.00	3.35	2.27	2.22
Crotonaldehyde	1.53	2.04	1.75	3.07	3.27	3.66	2.16
2,5-Dimethylbenzaldehyde	--	--	--	--	--	--	--
Formaldehyde	0.57	0.73	0.83	0.99	0.79	0.97	1.11
Hexaldehyde	2.43	5.02	3.77	0.00	3.66	4.51	4.38
Isovaleraldehyde	--	--	--	--	--	--	--
Propionaldehyde	1.89	1.55	2.13	2.12	2.94	2.10	3.45
Tolualdehydes	4.62	4.82	4.66	7.54	3.79	3.84	3.73
Valeraldehyde	3.65	6.00	3.64	9.07	4.52	4.00	3.30
Average CV by Site	1.94	2.89	2.29	2.53	2.88	2.62	2.42
# of pairs by site	24	24	21	4	36	32	10

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting duplicate samples; purple shading identifies sites collecting collocated samples; and brown shading identifies sites for which replicate analyses were run on only individual samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-13. Carbonyl Compound Analytical Precision: Coefficient of Variation Based on Replicate Analyses by Site and Pollutant (Continued)

Pollutant	NRNJ	NROK	OCOK	ORFL	PACO	*PXSS*	RICO
Acetaldehyde	0.72	0.33	0.40	1.05	0.31	0.44	1.54
Acetone	0.60	0.35	1.41	1.43	1.62	0.57	1.08
Benzaldehyde	3.36	2.24	2.64	3.31	4.35	2.57	4.04
2-Butanone	1.56	1.15	1.32	3.62	1.95	1.80	2.92
Butyraldehyde	1.70	1.33	2.74	3.43	3.83	2.39	4.00
Crotonaldehyde	3.16	0.43	1.95	2.20	2.73	2.12	5.70
2,5-Dimethylbenzaldehyde	--	--	--	--	--	--	--
Formaldehyde	0.62	0.87	0.59	1.02	0.52	0.76	1.63
Hexaldehyde	2.73	3.27	3.69	3.64	0.00	3.05	5.10
Isovaleraldehyde	--	--	--	--	--	--	--
Propionaldehyde	2.24	1.98	2.43	2.94	2.10	2.16	2.99
Tolualdehydes	4.95	4.80	3.69	4.83	4.21	3.54	5.01
Valeraldehyde	2.33	3.34	3.00	3.39	5.44	3.12	4.84
Average CV by Site	2.18	1.83	2.17	2.80	2.46	2.05	3.53
# of pairs by site	12	8	24	22	7	43	9

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting duplicate samples; purple shading identifies sites collecting collocated samples; and brown shading identifies sites for which replicate analyses were run on only individual samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-13. Carbonyl Compound Analytical Precision: Coefficient of Variation Based on Replicate Analyses by Site and Pollutant (Continued)

Pollutant	ROIL	*S4MO*	*SEWA*	*SKFL*	SPIL	*SYFL*	TMOK
Acetaldehyde	0.70	0.83	2.14	0.48	0.48	1.05	0.35
Acetone	0.71	0.79	0.72	0.56	0.32	0.93	1.41
Benzaldehyde	2.24	3.76	3.87	3.67	3.16	4.28	3.48
2-Butanone	2.74	1.66	1.52	2.68	0.97	3.41	1.76
Butyraldehyde	3.82	2.53	3.47	3.53	1.62	3.15	2.70
Crotonaldehyde	2.07	2.36	4.18	2.16	2.44	1.98	2.19
2,5-Dimethylbenzaldehyde	--	--	--	--	--	--	--
Formaldehyde	0.81	0.84	1.88	0.86	0.61	0.59	0.46
Hexaldehyde	4.30	3.54	4.44	3.79	3.60	3.51	4.17
Isovaleraldehyde	--	--	--	--	--	--	--
Propionaldehyde	3.66	2.60	3.06	2.72	1.70	3.08	1.56
Tolualdehydes	3.89	3.81	4.40	4.10	4.37	4.60	3.33
Valeraldehyde	4.13	3.61	4.36	4.65	2.97	4.50	3.43
Average CV by Site	2.64	2.40	3.09	2.65	2.02	2.83	2.26
# of pairs by site	10	24	24	22	20	21	24

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting duplicate samples; purple shading identifies sites collecting collocated samples; and brown shading identifies sites for which replicate analyses were run on only individual samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-13. Carbonyl Compound Analytical Precision: Coefficient of Variation Based on Replicate Analyses by Site and Pollutant (Continued)

Pollutant	TOOK	TROK	WPIN	YUOK	# of pairs	Average by Pollutant
Acetaldehyde	0.57	0.40	0.95	0.33	671	0.81
Acetone	0.60	0.50	0.54	0.29	671	0.75
Benzaldehyde	3.44	3.90	3.70	3.32	656	3.59
2-Butanone	1.19	0.77	2.81	1.01	667	1.96
Butyraldehyde	1.58	2.22	3.03	3.11	668	2.67
Crotonaldehyde	2.05	2.10	3.10	2.00	666	2.52
2,5-Dimethylbenzaldehyde	--	--	--	--	--	--
Formaldehyde	0.64	0.78	0.68	0.85	672	0.84
Hexaldehyde	3.55	3.54	3.27	3.73	655	3.53
Isovaleraldehyde	--	--	--	--	--	--
Propionaldehyde	1.83	1.76	2.39	2.57	660	2.44
Tolualdehydes	3.83	3.95	4.24	4.95	605	4.36
Valeraldehyde	3.53	3.16	3.97	4.05	653	3.85
Average CV by Site	2.07	2.10	2.61	2.38	7,244	2.48
# of pairs by site	24	24	38	24		

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting duplicate samples; purple shading identifies sites collecting collocated samples; and brown shading identifies sites for which replicates were run on only individual samples.
BOLD ITALICS = EPA-designated NATTS Site

24.3.5 PAH Analytical Precision

Table 24-14 presents analytical precision results from replicate analyses of collocated and select individual samples as the CV per pollutant per site, the average CV per site, the average CV per pollutant, and the overall average CV across the PAHs listed. Sites at which collocated PAH samples were collected are highlighted in blue in Table 24-14 while sites for which replicates were run on individual field samples are highlighted in brown. Collocated PAH samples were collected at DEMI, RUCA, and SEWA; replicate analyses were run on only individual PAH samples for the remaining sites. However, analytical replicates could be run on samples collected at any of sites (e.g., replicates could be run on individual PAH samples as well as collocated samples for additional precision information for RUCA).

The CVs range from 0 percent (benzo(a)pyrene for BTUT and benzo(k)fluoranthene for WADC) to 10.96 percent (cyclopenta(c,d)pyrene for BXNY), indicating that every pollutant-site combination has a CV less than 15 percent. The pollutant-specific average CV, as shown in orange in Table 24-14, ranges from 0.70 percent (phenanthrene) to 3.62 percent (benzo(k)fluoranthene), indicating that all of the pollutant-specific average CVs are less than 4 percent. The site-specific average CV, as shown in green in Table 24-14, ranges from 1.37 percent (GPCO) to 2.27 percent (UNVT). The overall average analytical precision is 1.79 percent CV.

Table 24-14. PAH Analytical Precision: Coefficient of Variation Based on Replicate Analyses by Site and Pollutant

Pollutant	***BOMA***	***BTUT***	***BXNY***	***CELA***	***DEMI***	***GLKY***	***GPCO***
Acenaphthene	1.00	2.57	1.33	1.53	1.25	2.12	0.93
Acenaphthylene	1.09	2.90	1.26	1.73	1.74	0.74	1.75
Anthracene	5.99	2.34	2.35	1.94	3.31	2.90	1.70
Benzo(a)anthracene	1.34	1.43	0.81	0.46	0.63	0.48	0.63
Benzo(a)pyrene	1.66	0.00	1.88	1.65	1.86	1.66	1.25
Benzo(b)fluoranthene	6.35	5.43	1.32	2.45	1.65	9.19	2.04
Benzo(e)pyrene	1.21	0.40	0.92	0.72	0.85	0.63	0.70
Benzo(g,h,i)perylene	1.36	0.46	0.88	1.66	0.70	0.99	0.69
Benzo(k)fluoranthene	4.91	--	6.24	--	10.03	--	0.61
Chrysene	0.73	2.79	0.45	0.67	0.50	1.00	0.93
Coronene	6.56	1.53	2.43	2.26	2.44	1.17	1.67
Cyclopenta(c,d)pyrene	1.82	1.22	10.96	2.86	1.81	1.12	2.09
Dibenz(a,h)anthracene	1.37	--	1.89	--	1.23	0.86	2.53
Fluoranthene	1.24	1.84	0.95	0.94	1.32	0.83	1.61
Fluorene	0.83	0.99	0.90	0.63	1.55	1.93	1.01
9-Fluorenone	1.14	1.98	0.88	1.28	1.03	1.29	1.79
Indeno(1,2,3-c,d)pyrene	1.71	0.51	1.00	1.32	1.31	0.64	0.89
Naphthalene	1.11	2.23	0.94	2.53	1.38	3.38	1.87
Perylene	1.65	--	1.19	2.53	9.10	1.02	1.12
Phenanthrene	0.83	1.66	0.77	0.55	0.62	0.49	0.50
Pyrene	1.04	1.90	0.81	1.05	1.12	0.99	1.83
Retene	2.08	2.72	0.97	1.55	1.59	1.42	1.92
Average CV by Site	2.14	1.84	1.87	1.52	2.14	1.66	1.37
# of pairs by site	14	15	17	14	21	16	12

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting collocated samples and brown shading identifies sites for which replicate analyses were run on only individual samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-14. PAH Analytical Precision: Coefficient of Variation Based on Replicate Analyses by Site and Pollutant (Continued)

Pollutant	*NBIL*	*PRRI*	*PXSS*	*RIVA*	*ROCH*	*RUCA*	*S4MO*
Acenaphthene	1.12	0.75	0.74	1.34	5.95	1.65	0.81
Acenaphthylene	3.35	0.94	1.73	3.61	2.28	1.68	1.70
Anthracene	1.37	4.93	2.05	1.16	2.02	3.05	1.95
Benzo(a)anthracene	0.70	1.11	0.61	0.36	0.83	0.68	1.42
Benzo(a)pyrene	1.46	2.48	0.31	--	1.40	1.52	0.63
Benzo(b)fluoranthene	6.49	3.96	0.73	1.22	2.94	0.75	2.47
Benzo(e)pyrene	0.83	0.75	0.74	0.37	1.05	1.14	0.69
Benzo(g,h,i)perylene	0.68	0.84	0.75	0.65	1.11	1.67	1.27
Benzo(k)fluoranthene	7.27	3.55	1.27	--	3.43	2.16	0.16
Chrysene	0.61	0.70	0.92	0.76	0.53	0.82	0.56
Coronene	3.62	4.53	1.53	5.38	3.42	3.19	3.07
Cyclopenta(c,d)pyrene	2.92	2.63	2.04	1.74	2.45	1.80	1.13
Dibenz(a,h)anthracene	3.65	4.83	1.58	--	3.95	2.26	1.32
Fluoranthene	0.94	1.00	1.41	0.95	1.56	1.40	1.08
Fluorene	0.96	0.81	1.22	2.07	0.84	1.77	1.53
9-Fluorenone	0.99	1.18	2.49	1.21	1.75	1.74	1.30
Indeno(1,2,3-c,d)pyrene	0.65	2.69	0.65	0.57	1.14	1.35	1.09
Naphthalene	1.73	1.36	2.75	2.20	1.54	2.09	2.05
Perylene	1.57	2.61	2.97	1.61	1.91	2.45	2.06
Phenanthrene	0.53	0.51	0.75	0.66	0.66	0.69	0.76
Pyrene	0.93	0.86	1.48	1.15	1.75	1.74	1.05
Retene	1.32	1.14	1.75	1.50	2.46	2.14	2.59
Average CV by Site	1.99	2.01	1.39	1.50	2.04	1.72	1.40
# of pairs by site	15	13	14	14	13	47	12

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting collocated samples and brown shading identifies sites for which replicate analyses were run on only individual samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-14. PAH Analytical Precision: Coefficient of Variation Based on Replicate Analyses by Site and Pollutant (Continued)

Pollutant	*SEWA*	SJJCA	*SKFL*	*UNVT*	*WADC*	# of Pairs	Average by Pollutant
Acenaphthene	1.22	0.80	2.17	2.68	1.29	259	1.65
Acenaphthylene	1.75	2.49	0.53	1.09	1.97	155	1.81
Anthracene	1.74	4.89	3.99	1.29	5.99	205	2.89
Benzo(a)anthracene	1.12	1.21	--	--	0.32	106	0.83
Benzo(a)pyrene	1.61	2.65	--	--	0.39	85	1.40
Benzo(b)fluoranthene	2.46	1.56	1.26	1.03	1.57	165	2.89
Benzo(e)pyrene	1.55	1.44	0.89	--	0.98	148	0.88
Benzo(g,h,i)perylene	1.03	0.99	1.28	--	1.18	179	1.01
Benzo(k)fluoranthene	--	3.84	--	--	0.00	50	3.62
Chrysene	0.88	1.01	1.03	1.38	0.61	228	0.89
Coronene	6.02	2.56	2.07	10.66	2.47	177	3.50
Cyclopenta(c,d)pyrene	5.62	2.38	2.87	4.73	3.05	79	2.91
Dibenz(a,h)anthracene	--	--	--	--	0.61	48	2.17
Fluoranthene	1.74	1.16	1.08	1.77	1.18	309	1.26
Fluorene	2.42	1.81	1.63	1.28	0.92	224	1.32
9-Fluorenone	1.55	1.41	0.96	1.41	1.47	311	1.41
Indeno(1,2,3-c,d)pyrene	1.00	0.71	0.85	--	0.72	144	1.04
Naphthalene	2.29	2.10	1.99	1.04	1.14	314	1.88
Perylene	--	--	--	--	1.43	63	2.37
Phenanthrene	0.73	0.61	0.54	0.80	0.57	313	0.70
Pyrene	1.83	1.35	1.15	1.53	1.23	303	1.31
Retene	1.70	1.38	1.88	1.06	1.81	232	1.74
Average CV by Site	2.01	1.82	1.54	2.27	1.40	4,097	1.79
# of pairs by site	23	15	13	13	13		

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting collocated samples and brown shading identifies sites for which replicate analyses were run on only individual samples.
BOLD ITALICS = EPA-designated NATTS Site

24.3.6 Metals Analytical Precision

Table 24-15 presents analytical precision results from replicate analyses of collocated and select individual samples as the CV per pollutant per site, the average CV per site, the average CV per pollutant, and the overall average CV across the metals listed. Sites at which collocated metals samples were collected are highlighted in blue in Table 24-15 while sites for which replicates were run on only individual field samples are highlighted in brown. Collocated metals samples were collected at six sites; replicate analyses were run on individual metals samples for the remaining sites. However, analytical replicates could be run on any of the sites collecting metals samples (e.g., replicates could be run on individual metals samples as well as collocated samples for additional precision information for ASKY-M).

The CVs exhibit low- to mid-level variability, ranging from 0 percent (for several sites and pollutants) to 34.57 percent (mercury for BLKY). The pollutant-specific average CV, as shown in orange in Table 24-15, ranges from 1.33 percent (lead and manganese) to 14.73 percent (mercury), indicating that none of the pollutant-specific average CVs are greater than or equal to 15 percent. The site-specific average CV, as shown in green in Table 24-15, ranges from 2.66 percent (TOOK) to 6.85 percent (PAFL); all 19 sites sampling metals have site-specific average CVs less than 15 percent. The overall average analytical precision is 4.79 percent CV.

Table 24-15. Metals Analytical Precision: Coefficient of Variation Based on Replicate Analyses by Site and Pollutant

Pollutant	ASKY-M	BAKY	BLKY	*BOMA*	*BTUT*	*GLKY*	*GPCO*
Antimony	0.93	1.23	1.52	0.89	1.05	1.16	1.36
Arsenic	4.14	6.61	3.15	9.87	7.33	9.23	3.83
Beryllium	8.18	7.27	**15.28**	**15.31**	8.60	**19.03**	**27.06**
Cadmium	1.97	3.19	5.39	4.05	4.51	4.57	5.39
Chromium	0.25	0.36	1.17	0.92	0.58	1.20	--
Cobalt	1.17	1.36	2.23	2.22	1.84	3.70	1.48
Lead	0.91	1.74	0.59	0.73	1.62	0.77	0.64
Manganese	0.74	2.03	0.53	1.05	0.81	1.16	0.70
Mercury	12.95	**24.54**	**34.57**	11.26	13.86	13.25	6.75
Nickel	0.93	3.27	4.63	2.43	3.84	3.16	1.70
Selenium	4.89	2.15	5.97	13.00	11.29	6.39	7.74
Average CV by Site	3.37	4.89	6.82	5.61	5.03	5.78	5.66
# of pairs by site	24	10	8	116	26	93	26

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting collocated samples and brown shading identifies sites for which replicate analyses were run on only individual samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-15. Metals Analytical Precision: Coefficient of Variation Based on Replicate Analyses by Site and Pollutant (Continued)

Pollutant	LEKY	*NBIL*	OCOK	PAFL	*PXSS*	*S4MO*	*SEWA*
Antimony	0.94	1.66	1.73	1.97	0.83	1.33	0.92
Arsenic	4.13	1.85	2.66	5.94	4.10	6.55	9.62
Beryllium	6.89	**17.85**	6.76	**17.89**	5.89	13.60	0.00
Cadmium	2.91	4.53	4.88	12.92	4.27	2.68	3.41
Chromium	0.14	4.92	1.73	0.00	--	2.54	--
Cobalt	4.64	4.92	3.71	0.00	0.74	2.32	4.30
Lead	0.90	2.21	2.24	0.92	0.54	0.82	0.62
Manganese	1.12	1.93	2.65	2.04	0.83	0.77	0.65
Mercury	**18.52**	7.02	7.17	**26.13**	10.48	12.92	**21.60**
Nickel	2.19	12.74	3.54	0.99	0.96	1.88	1.65
Selenium	9.10	3.01	3.52	6.60	6.27	7.15	10.54
Average CV by Site	4.68	5.70	3.69	6.85	3.49	4.78	5.33
# of pairs by site	10	11	16	7	11	233	12

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting collocated samples and brown shading identifies sites for which replicate analyses were run on only individual samples.
BOLD ITALICS = EPA-designated NATTS Site

Table 24-15. Metals Analytical Precision: Coefficient of Variation Based on Replicate Analyses by Site and Pollutant (Continued)

Pollutant	*SJJCA*	TMOK	TOOK	TROK	YUOK	# of Pairs	Average by Pollutant
Antimony	1.46	1.50	1.10	1.33	3.25	897	1.38
Arsenic	5.75	2.53	1.44	2.28	1.86	889	4.89
Beryllium	**18.24**	4.35	4.63	5.98	6.29	794	11.01
Cadmium	4.09	8.29	3.74	2.52	7.78	897	4.79
Chromium	0.00	2.24	1.70	2.85	1.73	386	1.40
Cobalt	2.61	5.50	1.72	4.73	2.55	730	2.72
Lead	0.54	3.00	1.31	3.04	2.05	897	1.33
Manganese	0.58	1.98	1.25	2.33	2.18	897	1.33
Mercury	**26.75**	6.54	4.82	**15.19**	5.60	414	14.73
Nickel	1.26	5.72	5.24	3.22	1.29	832	3.19
Selenium	6.22	2.88	2.30	2.36	1.84	844	5.96
Average CV by Site	6.14	4.05	2.66	4.17	3.31	8,477	4.79
# of pairs by site	9	16	242	14	13		

-- = No pairs with concentrations greater than or equal to the MDL.
Bold = CV greater than or equal to 15 percent
Green shading indicates the site-specific average CV for this method.
Orange shading indicates the pollutant-specific average CV; the overall average CV for this method is calculated from the pollutant-specific averages and is provided at the bottom of the orange column.
Blue shading identifies sites collecting collocated samples and brown shading identifies sites for which replicate analyses were run on only individual samples.
BOLD ITALICS = EPA-designated NATTS Site

24.3.7 Hexavalent Chromium Analytical Precision

Table 24-16 presents analytical precision results for replicate analyses of collocated samples as the CV per site and the overall average CV for hexavalent chromium. RIVA is the only site at which hexavalent chromium sampling was conducted in 2015 and 2016 (with sampling discontinued in June 2016). The analytical precision for hexavalent chromium is 6.53 percent, as shown in orange in Table 24-16, which is considerably less than the MQO of 15 percent CV for method precision.

Table 24-16. Hexavalent Chromium Analytical Precision: Coefficient of Variation Based on Replicate Analyses by Site

Pollutant	*RIVA*	# of pairs	Average by Pollutant
Hexavalent Chromium	6.53	13	6.53

Bold = CV greater than or equal to 15 percent
Orange shading indicates the overall average CV for this method.
Blue shading identifies sites collecting collocated samples.
BOLD ITALICS = EPA-designated NATTS Site

24.4 Accuracy

Laboratories typically evaluate their accuracy by analyzing audit samples that are prepared by an external source. The pollutants and the respective concentrations of the audit samples are unknown to the laboratory. The laboratory analyzes the samples and the external source evaluates the measured concentrations against a comparison concentration of those audit samples and calculates a percent difference. Accuracy, or bias, indicates the extent to which experimental measurements represent their corresponding "true" or "actual" values.

Laboratories participating in the NATTS program are provided with proficiency test (PT) audit samples for VOCs, carbonyl compounds, PAHs, and metals, which are used to quantitatively measure analytical accuracy. PT samples for hexavalent chromium were discontinued after monitoring for this pollutant was no longer a mandatory part of the NATTS program (2014). Tables 24-17 through 24-20 present ERG's results for PT audit samples analyzed in 2015 and 2016. Results for PT audit samples are presented as a percent difference. Percent difference audit results are calculated as follows:

$$\text{Percent Difference} = \frac{X_{lab} - X_{true}}{X_{true}} \times 100$$

Where:

X_{lab} is the analytical result from the laboratory;
X_{true} is the true concentration of the audit sample.

Percent differences of ± 25 percent are acceptable. Note that the "true" value used in the calculations above can be based on the mean value of the confirmation laboratory's results or the mean result of all participating NATTS laboratories and is also indicated in the tables that follow.

The results of the 2015 and 2016 PT audit samples show that few of the pollutants for which PT audit samples were analyzed exceed the MQO for accuracy. Of the 143 results provided in Tables 24-17 through 24-20, only three exceed the MQO for accuracy (two VOCs and one PAH). However, none failed multiple audits in 2015 and 2016.

Table 24-17. TO-15 NATTS PT Audit Samples[1]

Pollutant	May 2015	August 2016	February 2016	June 2016
Acrolein	12.5	NS	7.1	-9.0
Benzene	0.1	0.8	11.5	11.2
1,3-Butadiene	5.9	**-25.4**	4.8	-12.9
Carbon Tetrachloride	**28.6**	8.6	NS	21.3
Chloroform	24.8	3.7	17.9	13.1
1,2-Dibromoethane	-1.8	-11	1.2	-3.3
1,2-Dichloroethane	15.7	-1.4	7.3	8.5
Dichloromethane	NS	7.9	15.4	13.2
1,2-Dichloropropane	3.1	-6.7	1.0	8.6
cis-1,3-Dichloropropene	8.4	-12	12.1	6.8
trans-1,3-Dichloropropene	1.0	-22.6	0.2	-5.3
1,1,2,2-Tetrachloroethane	-4.3	-12.4	-0.3	14.5
Tetrachloroethylene	0.8	-2.4	0.4	0.5
Trichloroethylene	6.8	-0.3	6.0	-3.7
Vinyl chloride	7.4	-4.5	11.4	1.0

[1] The true value is based on the mean of participating NATTS laboratories.
Bold = Greater than ± 25 percent MQO
NS = Not spiked onto PT audit sample provided to the laboratory

Table 24-18. TO-11A NATTS PT Audit Samples[1]

Pollutant	March 2015	February 2016	June 2016
Acetaldehyde	-13.2	-0.9	-2.1
Benzaldehyde	3.7	1.3	-0.4
Formaldehyde	-12.6	-6.7	-7.9
Propionaldehyde	-10.5	-8.3	-8.9

NS = Not spiked onto PT audit sample provided to the laboratory
[1] The true value is based on the mean of participating NATTS laboratories.
Bold = Greater than ± 25 percent MQO

Table 24-19. TO-13A NATTS PT Audit Samples[1]

Pollutant	June 2015	November 2015	November 2016
Acenaphthene	8.8	NS	7.1
Anthracene	NS	1.1	9.3
Benzo(a)pyrene	10.1	1.9	14.5
Fluoranthene	10.2	6.2	12.7
Fluorene	7.3	11.4	18
Naphthalene	**35.5**	18.5	24.8
Phenanthrene	-4.7	0.8	10.6
Pyrene	-2.6	-1.9	15.1

NS = Not spiked onto PT audit sample provided to the laboratory.
Bold = Greater than ± 25 percent MQO
[1] Audit result based on percent difference from mean of participating NATTS laboratories.

Table 24-20. Metals NATTS PT Audit Samples[1]

Pollutant	June 2015[2]	November 2015[2]	June 2016		November 2016	
			Teflon®	Quartz	Teflon®	Quartz
Antimony	-11.3	-11.1	-4.6	-15.7	8.3	-24.2
Arsenic	6.3	2.3	-3.8	0.3	0.2	0.8
Beryllium	11.7	-1.0	-6.3	4.1	-3.8	0.2
Cadmium	10.4	6.5	-4.8	6.9	0	3.8
Cobalt	6.3	7.4	-4.4	7.2	-2.8	3.0
Lead	7.5	1.0	-5.0	-1.0	-0.6	1.2
Manganese	6.5	-0.4	10.1	6.9	0.3	4.6
Nickel	21.4	NS	-18.3	5.2	-0.5	1.5
Selenium	NS	13.3	0.9	3.6	-2.0	-2.4

NS = Not spiked onto PT audit sample provided to the laboratory.
Bold = Greater than ± 25 percent MQO
[1] Audit result based on percent difference from mean of participating NATTS laboratories.
[2] Teflon® audit samples not available prior to 2016.

In 2012, ERG was approved for the sampling and analysis of lead for adherence to the National Ambient Air Quality Standards (NAAQS) using ICP-MS analysis (EPA, 2012). This approval requires additional quality assurance steps, including the analysis of quarterly audit strips. Tables 24-21 and 24-22 provide the results of the quarterly NAAQS audit results for lead for ERG for 2015 and 2016, respectively. Audit results are presented for Teflon® filters, the only filter type for which ERG receives under the NMP. More than 80 percent of the audit results are within the percent recovery target of ± 10 percent.

Table 24-21. 2015 Lead NAAQS Quarterly Audit Samples[1]

Pollutant	Level	Analysis #	Q1 2015	Q2 2015	Q3 2015	Q4 2015
			Teflon®			
Lead	Low	1	-9.2	2.5	-8.1	**-15.4**
		2	-4.3	-2.9	-4.9	**-17.1**
		3	-7.9	-4.3	-4.9	**-14.5**
Lead	High	1	-2.2	0.3	-6.3	**-11.2**
		2	-5.7	5.6	-4.7	-6.0
		3	-2.2	-2.5	-9.3	-3.4

[1] Audit result based on percent difference from mean of participating NATTS laboratories.
Bold = Greater than ± 10 percent difference target

Table 24-22. 2016 Lead NAAQS Quarterly Audit Samples[1]

Pollutant	Level	Analysis #	Q1 2016	Q2 2016	Q3 2016	Q4 2016
			Teflon®			
Lead	Low	1	-1.8	-6.6	3.9	-3.8
		2	-1.7	**-17.8**	5.8	-9.3
		3	-2.0	**-17.1**	5.8	-1.6
Lead	High	1	-5.8	-5.1	-5.6	-9.1
		2	-6.1	**-11.6**	-6.8	**-13.6**
		3	-6.1	**-12.4**	**-11.4**	**-12.0**

[1] Audit result based on percent difference from mean of participating NATTS laboratories.
Bold = Greater than ± 10 percent difference target

The accuracy of the 2015 and 2016 NMP monitoring data can also be assessed qualitatively by reviewing the accuracy of the monitoring methods and how they were implemented:

- The sampling and analytical methods used during the 2015 and 2016 monitoring effort have been approved by EPA for accurately measuring ambient levels of various pollutants - an approval that is based on many years of research into the development of ambient air monitoring methodologies.

- When collecting and analyzing ambient air samples, field sampling staff and laboratory analysts are required to strictly adhere to quality control and quality assurance guidelines detailed in the respective monitoring methods. This strict adherence to the well-documented sampling and analytical methods suggests that the 2015 and 2016 monitoring data accurately represent ambient air quality.

25.0 Results, Conclusions, and Recommendations

This section summarizes the results of the data analyses contained in this report, renders conclusions based on those results, and presents recommendations applicable to future air toxics monitoring efforts. As demonstrated by the results of the data analyses discussed throughout this report, NMP data offer a wealth of information for assessing air quality by evaluating trends, patterns, correlations, and the potential for health risk. NMP data should ultimately assist a wide range of audiences in understanding the complex nature of ambient air pollution.

25.1 Summary of Results

Analyses of the 2015 and 2016 monitoring data identified the following notable results, observations, trends, and patterns in the program-level and state- and site-specific air monitoring data.

25.1.1 Program-level Results Summary

- *Number of participating sites*. Twenty of the 53 monitoring sites are EPA-designated NATTS sites. An additional 33 UATMP sites participated in the NMP in 2015 and 2016.

- *Total number of samples collected and analyzed*. Over 15,300 valid samples were collected at participating program sites and analyzed at the ERG laboratory, yielding more than 445,000 valid measurements of air toxics, including primary, duplicate, collocated, and replicate results.

- *Detects*. Of the 199 pollutants for which statistical summaries are provided in Tables 4-1 through 4-6, all but four were detected at least once over the course of the two-year monitoring effort. The detection of a given pollutant is subject to the sensitivity limitations associated with the analytical methods used and the limitations of the instruments. Simply stated, an MDL is the lowest concentration of a target pollutant that can be measured and reported with 99 percent confidence that the pollutant concentration is greater than zero. Approximately 54 percent of the reported measurements were greater than the associated MDLs. At the method level, this percentage varies considerably, from 40 percent for VOCs to 100 percent for methane. Quantification less than the MDL is possible and an acceptable analytical result; therefore, these results are incorporated into the data analyses. These measurements account for 12 percent of concentrations. Non-detects account for the remaining 34 percent of results.

- *Program-level Pollutants of Interest*. The pollutants of interest at the program-level are based on the total number of concentrations greater than the associated risk screening value, or those “failing the screen”. Concentrations of 39 pollutants failed at least one scree; of those pollutants, 13 were identified as program-level pollutants of interest, seven VOCs (benzene, 1,3-butadiene, carbon tetrachloride, *p*-dichlorobenzene, 1,2-dichloroethane, ethylbenzene, and hexachloro-1,3-butadiene),

two carbonyl compounds (acetaldehyde and formaldehyde), three PAHs (acenaphthene, fluorene, and naphthalene), and one metal (arsenic).

- *Seasonal Trends*. Fewer pollutants exhibited identifiable seasonal trends in the concentrations measured during the 2015 and 2016 program years (at least from a program-level perspective). Formaldehyde concentrations tended to be highest during the warmer months of the year, similar to past years. Acetaldehyde concentrations exhibit a similar pattern, but to a lesser degree. Fluorene concentrations also exhibited this seasonal trend. Conversely, benzene and 1,3-butadiene concentrations tended to be higher during the colder months of the year; this is also true for naphthalene, particularly during the fourth quarter.

25.1.2 State-level Results Summary

Arizona.

- The Arizona monitoring sites are located in Phoenix. PXSS is a NATTS site; SPAZ is a UATMP site.

- VOCs, carbonyl compounds, PAHs, and metals (PM_{10}) were sampled for at PXSS. VOCs were sampled for at SPAZ.

- Twenty pollutants failed screens for PXSS, 10 of which contributed to 95 percent of failed screens. PXSS failed the second highest number of screens among all NMP sites. Eight pollutants failed screens for SPAZ, six of which contributed to 95 percent of failed screens.

- Formaldehyde has the highest annual average concentration for 2016 among the pollutants of interest for PXSS, followed by acetaldehyde and benzene. Annual average concentrations for the carbonyl compounds could not be calculated for 2015 due to contamination issues with the collection system. Among the remaining pollutants of interest, benzene has the highest annual average concentration in 2015.

- Benzene has the highest annual average concentration for SPAZ for both years and is the only pollutant of interest with an annual average concentration greater than 1 $\mu g/m^3$.

- SPAZ and PXSS have the highest annual average concentrations of ethylbenzene among NMP sites sampling this pollutant for both years. SPAZ also has the highest annual average concentrations of benzene and *p*-dichlorobenzene in 2015 and 2016.

- Sampling for the site-specific pollutants of interest has occurred at PXSS and SPAZ for at least 5 consecutive years; thus, a trends analysis was conducted for each of the site-specific pollutants of interest. The detection rate and measured concentrations of 1,2-dichloroethane at PXSS has been steadily increasing in the recent years. The maximum concentration of 1,3-butadiene measured since the onset of sampling was measured at SPAZ in 2016.

- Formaldehyde has the highest cancer risk approximation among the pollutants of interest for PXSS; benzene has the highest cancer risk approximation among the pollutants of interest for SPAZ. None of the pollutants of interest for either site have noncancer hazard approximations greater than an HQ of 1.0.

- Formaldehyde is the highest emitted pollutant with a cancer toxicity factor in Maricopa County, while toluene is the highest emitted pollutant with a noncancer toxicity factor. Formaldehyde has the highest cancer toxicity-weighted emissions, while acrolein has the highest noncancer toxicity-weighted emissions for Maricopa County.

California.

- The three California monitoring sites are located in Los Angeles (CELA), Rubidoux (RUCA), and San Jose (SJJCA). All three are NATTS sites.

- PAHs were sampled for at each of the three sites. In addition, PM_{10} metals were also sampled for at SJJCA.

- Naphthalene failed the majority screens for CELA and RUCA, and thus, was identified as the sole pollutant of interest for these two sites. In addition to naphthalene, arsenic and nickel were also identified as pollutants of interest for SJJCA.

- Among the three California sites, CELA has the highest annual average concentrations of naphthalene for both 2015 and 2016.

- Sampling for the site-specific pollutants of interest has occurred at CELA, RUCA, and SJJCA for at least 5 consecutive years; thus, a trends analysis was conducted for each site for the site-specific pollutants of interest. Naphthalene concentrations exhibit a decreasing trend at CELA in recent years. This is also true for RUCA through 2015, but concentrations exhibit an increase for 2016.

- None of the pollutants of interest for the California sites have cancer risk approximations greater than 3 in-a-million; none of the pollutants of interest for the California sites have noncancer hazard approximations greater than an HQ of 1.0.

- Formaldehyde is the highest emitted pollutant with a cancer toxicity factor in Los Angeles, Riverside, and Santa Clara Counties. Formaldehyde has the highest cancer toxicity-weighted emissions for Los Angeles County, while hexavalent chromium has the highest cancer toxicity-weighted emissions for Riverside and Santa Clara Counties.

- Toluene is the highest emitted pollutant with a noncancer toxicity factor in Los Angeles, Riverside, and Santa Clara Counties, while acrolein has the highest noncancer toxicity-weighted emissions for all three counties.

Colorado.

- The NATTS site in Colorado is located in Grand Junction (GPCO). There are also six UATMP sites located northeast of Grand Junction in Garfield County. The sites are located in the towns of Battlement Mesa (BMCO), Silt (BRCO), Glenwood Springs (GSCO), Parachute (PACO), Carbondale (RFCO), and Rifle (RICO).

- VOCs, carbonyl compounds, PAHs, and metals (PM_{10}) were sampled for at GPCO. Carbonyl compounds and SNMOCs were sampled for at each of the Garfield County sites except RFCO. Between January and September 2015, canister samples collected at RFCO were analyzed for both VOC and SNMOCs, after which only SNMOCs were analyzed for the rest of 2015, as well as throughout 2016.

- Twenty pollutants failed at least one screen for GPCO, 12 of which contributed to 95 percent of failed screens. Three pollutants failed screens for BMCO, four pollutants failed screens for BRCO, GSCO, and RFCO, and five pollutants failed screens for PACO and RICO. Benzene is a pollutant of interest for all seven Colorado sites.

- Of the pollutants of interest for GPCO, formaldehyde had the highest annual concentration for 2015, although annual average concentrations could not be calculated for VOCs in 2015. Dichloromethane has the highest annual average concentration for GPCO for 2016, followed by formaldehyde.

- Where they could be calculated, benzene and formaldehyde had the highest annual average concentrations among the pollutants of interest for the Garfield County sites. RICO and PACO were the only Garfield County sites with annual average concentrations of these pollutants greater than 1 $\mu g/m^3$.

- PACO has the second (2015) and third (2016) highest annual average concentrations of benzene among all NMP sites sampling this pollutant.

- Sampling for the site-specific pollutants of interest has occurred at GPCO, BRCO, PACO, RICO, and RFCO for at least 5 consecutive years; thus, a trends analysis was conducted for the site-specific pollutants of interest. Notable trends include: The 1-year average concentration for several pollutants for GPCO are at a minimum for 2016, including acenaphthene, benzene, 1,3-butadiene, ethylbenzene, and naphthalene. The significant increase in the detection rate of 1,2-dichloroethane beginning at GPCO in 2012 continues through 2016. The highest fluoranthene concentrations measured since the onset of sampling at GPCO were measured in 2015 and 2016. Concentrations of acetaldehyde and formaldehyde decreased considerably at BRCO in 2016. Concentrations of acetaldehyde appear to have a decreasing trend at PACO. The detection rate of 1,3-butadiene has decreased considerably at PACO and RFCO, particularly in 2016.

- Formaldehyde has the highest cancer risk approximations among the pollutants of interest for GPCO. Benzene and formaldehyde have the highest cancer risk approximations for the Garfield County sites, depending on the year and whether annual average concentrations could be calculated. None of the pollutants of interest

for the Colorado monitoring sites have noncancer hazard approximations greater than an HQ of 1.0 (where they could be calculated).

- Benzene is the highest emitted pollutant with a cancer toxicity factor in both Mesa and Garfield Counties, while formaldehyde has the highest cancer toxicity-weighted emissions for both counties.

- Toluene is the highest emitted pollutant with a noncancer toxicity factor for Mesa County, while xylenes is the highest emitted pollutant with a noncancer toxicity factor for Garfield County. Acrolein has the highest noncancer toxicity-emissions for both counties.

District of Columbia.

- The Washington, D.C. monitoring site (WADC) is a NATTS site.

- PAHs were sampled for at WADC.

- Naphthalene and benzo(a)pyrene both failed screens for WADC, although naphthalene accounted for 98 percent of the total failed screens and therefore, was the only pollutant identified as a pollutant of interest.

- Naphthalene was detected in every valid PAH sample collected at WADC. The annual average concentration of naphthalene for 2015 is similar to the annual average concentration for 2016.

- Sampling for the site-specific pollutants of interest has occurred at WADC for at least 5 consecutive years; thus, a trends analysis was conducted for the site-specific pollutants of interest. Concentrations of naphthalene have a decreasing trend at WADC.

- The cancer risk approximations for naphthalene are 2.06 in-a-million and 2.22 in-a-million for 2015 and 2016, respectively. The noncancer hazard approximations for naphthalene are both considerably less than an HQ of 1.0.

- Benzene is the highest emitted pollutant with a cancer toxicity factor in the District of Columbia, while toluene is the highest emitted pollutant with a noncancer toxicity factor. Formaldehyde has the highest cancer toxicity-weighted emissions, while acrolein has the highest noncancer toxicity-weighted emissions in the District.

Florida.

- Three of the Florida monitoring sites are located in the Tampa-St. Petersburg-Clearwater CBSA (SYFL, AZFL, and SKFL) and two are located in the Orlando-Kissimmee-Sanford CBSA (ORFL and PAFL). SKFL and SYFL are NATTS sites while the other three are UATMP sites.

- Carbonyl compounds were sampled for at AZFL, ORFL, and SYFL. PAHs were sampled for at SKFL in addition to carbonyl compounds. Metals (PM_{10}) were sampled for at PAFL. Sampling at ORFL and PAFL was discontinued at the end of September 2016.

- Acetaldehyde and formaldehyde failed screens for all four Florida sites sampling carbonyl compounds. Naphthalene, fluorene, and acenaphthene also failed screens for SKFL. Arsenic and nickel are the speciated metals that failed screens for PAFL.

- Formaldehyde has the highest annual average concentration for all four sites sampling carbonyl compounds; annual average concentrations of acetaldehyde were nearly half the magnitude of the annual average of formaldehyde for each site.

- The 25 highest formaldehyde concentrations measured across the program in 2016 were measured at AZFL and SKFL. These sites have the second and fifth highest annual averages concentration of formaldehyde, respectively.

- The annual average concentrations of nickel were more than twice the annual average concentrations of arsenic for PAFL.

- Sampling for the site-specific pollutants of interest has occurred at the Florida sites for at least 5 consecutive years; thus, a trends analysis was conducted for the site-specific pollutants of interest. The following notable observations regarding trends include: Concentrations of naphthalene have a decreasing trend at SKFL through 2015 but increased somewhat for 2016. Concentrations of arsenic at PAFL have a decreasing trend.

- Formaldehyde has the highest cancer risk approximation for all four sites sampling carbonyl compounds, ranging from roughly 23 in-a-million to 95 in-a-million. Arsenic has the highest cancer risk approximation for PAFL. All noncancer hazard approximations for the pollutants of interest for the Florida sites are less than an HQ of 1.0.

- Benzene is the highest emitted pollutant with a cancer toxicity factor in Pinellas, Hillsborough, and Orange Counties. Formaldehyde has the highest cancer toxicity-weighted emissions for Pinellas and Hillsborough Counties, while hexavalent chromium has the highest cancer toxicity-weighted emissions for Orange County.

- Toluene is the highest emitted pollutant with a noncancer toxicity factor in Pinellas and Orange Counties, while hydrochloric acid this the highest emitted pollutant with a noncancer toxicity factor in Hillsborough County. Acrolein has the highest noncancer toxicity-weighted emissions for all three counties.

Illinois.

- Two Illinois monitoring sites are located near Chicago. NBIL is a NATTS site located in Northbrook and SPIL is a UATMP site located in Schiller Park. A third site, ROIL, is located in Roxana, on the Illinois border near St. Louis. Sampling at ROIL was discontinued at the end of July 2015, ending a three-year monitoring effort at this location.

- VOCs and carbonyl compounds were sampled for at all three Illinois sites. SNMOCs, PAHs, and metals (PM_{10}) were also sampled for at NBIL. NBIL is one of only two NMP sites sampling both VOCs and SNMOCs across both years of sampling.

- Twenty-three pollutants failed screens for NBIL; 14 pollutants failed screens for SPIL; and 10 pollutants failed screens for ROIL. Among the site-specific pollutants of interest, the three Illinois sites have six pollutants in common: two carbonyl compounds (acetaldehyde and formaldehyde) and four VOCs (benzene, 1,3-butadiene, carbon tetrachloride, and 1,2-dichloroethane).

- Formaldehyde and acetaldehyde have the highest and second-highest annual average concentrations, respectively, for NBIL and SPIL. Annual average concentrations for ROIL could not be calculated.

- NBIL has the highest annual average concentrations of acenaphthene and fluorene among NMP sites sampling PAHs.

- Sampling for the site-specific pollutants of interest has occurred at NBIL and SPIL for at least 5 consecutive years; thus, a trends analysis was conducted for the site-specific pollutants of interest. After several years of increasing, concentrations of acetaldehyde decreased significantly in 2015 and 2016 at NBIL while the opposite is true of formaldehyde concentrations measured at this site. Concentrations of fluoranthene have an increasing trend at NBIL while concentrations of naphthalene have a decreasing trend. Concentrations of benzene measured at NBIL are at a minimum in 2016; this is also true at SPIL.

- Formaldehyde has the highest cancer risk approximations for NBIL and SPIL, each of which is a magnitude higher than other cancer risk approximations for both sites. All noncancer hazard approximations for the pollutants of interest for the Illinois sites are less than an HQ of 1.0.

- Benzene is the highest emitted pollutant with a cancer toxicity factor in Cook County, while formaldehyde has the highest cancer toxicity-weighted emissions. Formaldehyde is the highest emitted pollutant with a cancer toxicity factor in Madison County, while coke oven emissions (PM) have the highest cancer toxicity emissions.

- Ethylene glycol is the highest emitted pollutant with a noncancer toxicity factor in Cook County, while toluene is the highest emitted pollutant with a noncancer toxicity factor Madison County. Acrolein has the highest noncancer toxicity-weighted emissions for both counties.

Indiana.

- There are two Indiana monitoring sites sampling under the NMP, one located in Indianapolis (WPIN) and a second located in Gary, near Chicago (INDEM). Both are UATMP sites.

- Carbonyl compounds were sampled for at WPIN and INDEM.

- Formaldehyde and acetaldehyde failed screens for both INDEM and WPIN. All measured detections of formaldehyde failed screens for both sites. All measured detections of acetaldehyde failed screens for INDEM while all but one acetaldehyde concentration measured at WPIN failed screens.

- Formaldehyde has the highest annual average concentrations for both sites.

- Sampling for the site-specific pollutants of interest has occurred at WPIN and INDEM for at least 5 consecutive years; thus, a trends analysis was conducted for the site-specific pollutants of interest. Concentrations of formaldehyde have a slight increasing trend at INDEM in recent years, with concentrations of acetaldehyde exhibiting a similar trend through 2015. Acetaldehyde concentrations have been decreasing at WPIN since 2010, although the rate of decrease slowed considerably in recent years. After a few years of decreasing, formaldehyde concentrations have an increasing trend at WPIN in 2015 and 2016.

- The cancer risk approximations for formaldehyde are an order of magnitude greater than the cancer risk approximations for acetaldehyde for both sites. The noncancer hazard approximations for the pollutants of interest for the Indiana sites are considerably less than an HQ of 1.0.

- Benzene is the highest emitted pollutant with a cancer toxicity factor in both Marion and Lake Counties while formaldehyde has the highest cancer toxicity-weighted emissions for both counties.

- Toluene is the highest emitted pollutant with a noncancer toxicity factor in both Lake and Marion Counties while acrolein has the highest noncancer toxicity-weighted emissions for both counties.

Kentucky.

- Three Kentucky monitoring sites are located in northeast Kentucky, two in Ashland (ASKY and ASKY-M) and one near Grayson Lake (GLKY). The Grayson Lake monitoring site is a NATTS site. One monitoring site is located south of Evansville, Indiana (BAKY). Three monitoring sites are located in or near the Calvert City area (ATKY, BLKY, and TVKY). The final monitoring site is located in Lexington, in north-central Kentucky (LEKY).

- Six of the eight Kentucky monitoring sites sampled for VOCs, with ASKY-M and BAKY as the exceptions. Five of the eight sites sampled for PM_{10} metals, with ASKY, ATKY, and TVKY as the exceptions. GLKY also sampled for PAHs and carbonyl compounds.

- The number of pollutants failing screens for the Kentucky sites varies from five (ASKY-M and BAKY) to 13 (GLKY, ATKY, BLKY, and LEKY).

- Of the pollutants of interest, formaldehyde has the highest annual average concentrations for GLKY. Manganese has the highest annual average concentrations for ASKY-M, while arsenic has the highest annual average concentrations for BAKY. Benzene has the highest annual average concentrations for ASKY, while

1,2-dichloroethane has the highest annual average concentrations for BLKY and TVKY. Benzene has the highest annual average concentration for ATKY in 2015, while 1,2-dichloroethane has the highest annual average concentration for the site in 2016. Carbon tetrachloride has the highest annual average concentration for LEKY in 2015; VOC sampling at LEKY was discontinued at the end of July 2016.

- ASKY-M has the highest annual average concentrations of arsenic for both 2015 and 2016 among NMP sites sampling PM_{10} metals. BAKY has the third (2015) and fifth (2016) highest annual concentrations of arsenic.

- The Calvert City sites account for the six highest annual average concentrations of 1,2-dichloroethane, four of the five highest annual average concentrations of carbon tetrachloride, and the highest annual average of 1,3-butadiene, with the highest annual average for each of these pollutants calculated for TVKY.

- Sampling for the site-specific pollutants of interest has occurred at ASKY, ASKY-M, GLKY, ATKY, BLKY, TVKY, and LEKY for at least 5 consecutive years; thus, a trends analysis was conducted for each of the site-specific pollutants of interest. Most notably, concentrations of benzene, 1,3-butadiene, and 1,2-dichloroethane have decreased at GLKY, while concentrations of formaldehyde have increased. Concentrations of 1,3-butadiene at BLKY also exhibit a decreasing trend.

- Formaldehyde has the highest cancer risk approximations among the pollutants of interest for GLKY, while arsenic has the highest cancer risk approximations for ASKY-M and BAKY. Benzene has the highest cancer risk approximations for ASKY and LEKY (2015 only). For ATKY, BLKY, and TVKY, 1,2-dichloroethane has the highest cancer risk approximations. The cancer risk approximations for TVKY for 1,2-dichloroethane are among the highest cancer risk approximations calculated for the site-specific pollutants of interest across the program for both years. None of the pollutants of interest for which noncancer hazard approximations could be calculated were greater than an HQ of 1.0.

- Benzene is the highest emitted pollutant with a cancer toxicity factor in all six Kentucky counties with NMP sites. Nickel has the highest cancer toxicity-weighted emissions for Boyd County; formaldehyde has the highest cancer toxicity-weighted emissions for Carter, Livingston, and Fayette Counties; naphthalene has the highest cancer-toxicity weighted emissions for Henderson County; and benzene has the highest cancer toxicity-weighted emissions for Marshall County.

- Toluene is the highest emitted pollutant with a noncancer toxicity factor in Boyd, Carter, Livingston, and Fayette Counties; carbonyl sulfide is the highest emitted pollutant with a noncancer toxicity factor in Henderson County; and methanol is the highest emitted pollutant with a noncancer toxicity factor in Marshall County. Acrolein has the highest noncancer toxicity-weighted emissions in five of the Kentucky counties, but ranks second to chlorine in Marshall County.

Massachusetts.

- The Massachusetts monitoring site (BOMA) is a NATTS site located in Boston.
- Metals (PM_{10}) and PAHs were sampled for at BOMA.
- Nine pollutants failed screens for BOMA, four of which were identified as pollutants of interest. Arsenic and naphthalene together accounted for nearly 90 percent of the site's failed screens.
- Of the pollutants of interest, naphthalene has the highest annual average concentration each year.
- The maximum concentration of nickel measured across the program was measured at BOMA.
- Sampling for the site-specific pollutants of interest has occurred at BOMA for at least 5 consecutive years; thus, a trends analysis was conducted for the site-specific pollutants of interest. Naphthalene concentrations have a decreasing trend at BOMA. The highest concentrations of nickel and cadmium measured since the onset of sampling were measured at BOMA in 2016.
- Arsenic has the highest cancer risk approximations for BOMA in 2015 and 2016. None of the pollutants of interest for BOMA have noncancer hazard approximations greater than an HQ of 1.0.
- Formaldehyde is the highest emitted pollutant with a cancer toxicity factor in Suffolk County and has the highest cancer toxicity-weighted emissions. Toluene is the highest emitted pollutant with a noncancer toxicity factor in Suffolk County, while acrolein has the highest noncancer toxicity-weighted emissions.

Michigan.

- The Michigan monitoring site (DEMI) is a NATTS site located in Dearborn, southwest of Detroit.
- VOCs, carbonyl compounds, and PAHs were sampled for at DEMI.
- Sixteen pollutants failed screens for DEMI, 10 of which were identified as pollutants of interest.
- Formaldehyde and acetaldehyde have the highest annual average concentrations for DEMI in 2015 and 2016.
- DEMI has the highest (2015) and third highest (2016) annual average concentrations of naphthalene among NMP sites sampling PAHs. DEMI is one of only two sites with an annual average concentration of naphthalene greater than 100 ng/m^3.
- Sampling for the site-specific pollutants of interest has occurred at DEMI for at least 5 consecutive years; thus, a trends analysis was conducted for the site-specific

pollutants of interest. Benzene concentrations exhibit a steady decreasing trend although concentrations have leveled out in recent years. Concentrations of acetaldehyde have a slow, steady increasing trend over the last several years of sampling.

- Formaldehyde has the highest cancer risk approximations for DEMI. None of the pollutants of interest for DEMI have noncancer hazard approximations greater than an HQ of 1.0.

- Benzene is the highest emitted pollutant with a cancer toxicity factor in Wayne County, while coke oven emissions (PM) have the highest cancer toxicity-weighted emissions. Hydrochloric acid is the highest emitted pollutant with a noncancer toxicity factor in Wayne County, while acrolein has the highest noncancer toxicity-weighted emissions.

Missouri.

- The NATTS site in Missouri (S4MO) is located in St. Louis.

- VOCs, carbonyl compounds, PAHs, and metals (PM_{10}) were sampled for at S4MO.

- Twenty-two pollutants failed at least one screen for S4MO, 12 of which contributed to 95 percent of failed screens. S4MO has the highest number of pollutants failing screens.

- Of the pollutants of interest for S4MO, formaldehyde and acetaldehyde have the highest annual average concentrations and are the only pollutants with annual average concentrations greater than 1 $\mu g/m^3$.

- S4MO has the third highest annual average concentration of *p*-dichlorobenzene (2015) among NMP sites sampling these pollutants.

- Sampling for the site-specific pollutants of interest has occurred at S4MO for at least 5 consecutive years; thus, a trends analysis was conducted for each of the site-specific pollutants of interest. Concentrations of acetaldehyde, benzene, and ethylbenzene have decreased significantly over the course of sampling.

- Formaldehyde has the highest cancer risk approximations for S4MO. None of the pollutants of interest for S4MO have a noncancer hazard approximation greater than an HQ of 1.0.

- Formaldehyde is the highest emitted pollutant with a cancer toxicity factor in St. Louis (city and county) and has the highest cancer toxicity-weighted emissions. Toluene is the highest emitted pollutant with a noncancer toxicity factor, while acrolein has the highest noncancer toxicity-weighted emissions in St. Louis (city and county).

New Jersey.

- Three UATMP sites in New Jersey are located in the New York-Newark-Jersey City CBSA and are located in the towns of Chester (CHNJ), Elizabeth (ELNJ), North Brunswick (NBNJ). At the end of 2015, the NBNJ site relocated to East Brunswick (NRNJ). Another UATMP site (CSNJ) is located in the Philadelphia-Camden-Wilmington CBSA.

- VOCs and carbonyl compounds were sampled for at the New Jersey sites.

- The number of pollutants failing at least one screen for the New Jersey sites ranged from nine (CHNJ) to 15 (CSNJ). The New Jersey sites have six pollutants of interest in common: acetaldehyde, formaldehyde, benzene, carbon tetrachloride, 1,3-butadiene, and 1,2-dichloroethane.

- Of the site-specific pollutants of interest, formaldehyde and acetaldehyde have the highest annual average concentrations for all but one of the New Jersey sites; the exception is CHNJ for 2015, when annual average concentrations could not be calculated for the carbonyl compounds.

- Sampling for the site-specific pollutants of interest has occurred at CHNJ, ELNJ, and NBNJ for at least 5 consecutive years; specifically, ELNJ is the longest running NMP site still participating in the NMP. As such, a trends analysis was conducted for the site-specific pollutants of interest for these sites. Concentrations of benzene have decreased significantly at ELNJ since the onset of sampling. This is also true of ethylbenzene, although concentrations have leveled out in the last few years. Concentrations of benzene also have decreasing trends at CHNJ and, to a lesser extent, NBNJ.

- With the exception of CHNJ in 2015, formaldehyde has the highest cancer risk approximations for the New Jersey sites. Carbon tetrachloride has the highest cancer risk approximation for CHNJ in 2015, when annual average concentrations could not be calculated for carbonyl compounds. None of the pollutants of interest for the New Jersey sites have noncancer hazard approximations greater than an HQ of 1.0.

- Benzene is the highest emitted pollutant with a cancer toxicity factor for Camden and Morris Counties, while formaldehyde is the highest emitted pollutant with a cancer toxicity factor in Union and Middlesex Counties. Formaldehyde has the highest toxicity-weighted emissions for each New Jersey county.

- Toluene is the highest emitted pollutant with a noncancer toxicity factor in Camden, Union, Middlesex, and Morris Counties. Acrolein has the highest noncancer toxicity-weighted emissions for each New Jersey county.

New York.

- The New York monitoring sites are located in Bronx (BXNY) and Rochester (ROCH). Both are NATTS sites.

- PAHs were sampled for at both BXNY and ROCH.

- Six pollutants failed screens for BXNY, four of which were identified as pollutants of interest. Naphthalene accounted for nearly 75 percent of failed screens for BXNY. Eight pollutants failed screens for ROCH, four of which were identified as pollutants of interest. Naphthalene accounted for nearly 40 percent of failed screens for ROCH.

- Naphthalene has the highest annual average concentrations for BXNY and ROCH, with the annual average concentrations for BXNY nearly twice the annual average calculated for ROCH.

- BXNY has the second (2015) and fourth (2016) highest annual average concentrations of naphthalene among NMP sites sampling PAHs and is one of only two NMP sites with an annual average concentration greater than 100 ng/m^3. ROCH has the third (2105) and fourth (2016) highest annual average concentrations of acenaphthene and fluorene among NMP sites sampling PAHs.

- Sampling for the site-specific pollutants of interest has occurred at BXNY and ROCH for greater than 5 consecutive years; thus, a trends analysis was conducted for each of the site-specific pollutants of interest. For both sites, the one-year average concentration of naphthalene is at a minimum for 2016 (based on years when annual averages could be calculated.)

- Naphthalene has the highest cancer risk approximations among the pollutants of interest for both ROCH and BXNY. Naphthalene is the only pollutant of interest for either site with a noncancer toxicity factor; the noncancer hazard approximations for naphthalene for both sites are considerably less than an HQ of 1.0.

- Benzene is the highest emitted pollutant with a cancer toxicity factor for Bronx County, while formaldehyde has the highest cancer toxicity-weighted emissions. *p*-Dichlorobenzene is the highest emitted pollutant with a cancer toxicity factor for Monroe County and has the highest cancer toxicity-weighted emissions.

- Toluene is the highest emitted pollutant with a noncancer toxicity factor for Bronx County, while chlorobenzene is the highest emitted pollutant with a noncancer toxicity factor for Monroe County. Acrolein has the highest noncancer toxicity-weighted emissions for both counties.

Oklahoma.

- There are seven UATMP sites in Oklahoma: three are located in Tulsa (TOOK, TMOK, and TROK), three are located in or near Oklahoma City (OCOK, NROK, and YUOK), and one is located south of Oklahoma City in Bradley (BROK).

- VOCs, carbonyl compounds, and metals (TSP) were sampled for at all three Tulsa sites, OCOK, and YUOK. VOCs, SNMOCs, and carbonyl compounds were sampled for at BROK and NROK. In addition, canister samples collected at BROK and NROK were also analyzed for methane. The Oklahoma sites are the only NMP sites sampling TSP metals and methane.

- Seventeen individual pollutants failed screens for each of the three Tulsa sites; 16 pollutants failed screens for OCOK; 15 failed screens for YUOK; 11 failed screens for BROK; and 10 failed screens for NROK.

- Formaldehyde and acetaldehyde have the highest annual average concentrations for each of the Oklahoma sites, where annual averages could be calculated.

- BROK's annual average concentration of acetaldehyde for 2015 is the highest annual average of this pollutant across the program; this site's annual average concentration of formaldehyde for 2015 ranks fourth highest. BROK's annual averages for 2016 are significantly less.

- The three Tulsa sites have some of the highest annual average concentrations of hexachloro-1,3-butadiene (2016 only) among NMP sites sampling VOCs.

- Sampling for the site-specific pollutants of interest has occurred at TOOK, TMOK, and OCOK for at least 5 consecutive years; thus, a trends analysis was conducted for the site-specific pollutants of interest. After several years of increasing, concentrations of several pollutants, including acetaldehyde, benzene, ethylbenzene, and manganese, decreased at TOOK after 2012 then have remained fairly static in recent years. Other pollutants exhibit this trend as well but the difference is less significant. Benzene and acetaldehyde concentrations have also been decreasing at TMOK but have leveled out in recent years. In addition, the detection rates of 1,2-dichloroethane have been increasing at TOOK, TMOK, and OCOK over the last five years of sampling.

- Formaldehyde has the highest cancer risk approximations for each of the Oklahoma monitoring sites, where they could be calculated. None of the pollutants of interest for the Oklahoma sites have a noncancer hazard approximation greater than an HQ of 1.0.

- Benzene is the highest emitted pollutant with a cancer toxicity factor in Oklahoma and Tulsa Counties while formaldehyde is the highest emitted pollutant with a cancer toxicity factor in Canadian and Grady Counties. Formaldehyde has the highest cancer toxicity-weighted emissions for Oklahoma, Canadian, and Grady Counties, while hexavalent chromium has the highest cancer toxicity-weighted emissions for Tulsa County.

- Toluene is the highest emitted pollutant with a noncancer toxicity factor in Oklahoma and Tulsa Counties, while formaldehyde is the highest emitted pollutant with a noncancer toxicity factor in Canadian and Grady Counties. Acrolein has the highest noncancer toxicity-weighted emissions for all four counties.

Rhode Island.

- The Rhode Island monitoring site (PRRI) is located in Providence and is a NATTS site.

- PAHs were sampled for at PRRI.

- Four pollutants failed screens for PRRI, two of which were identified as pollutants of interest (naphthalene and fluorene). Ninety-four percent of failed screens for PRRI are attributable to naphthalene.

- Naphthalene's annual average concentrations for both years are more than ten times the annual average concentrations of fluorene.

- Sampling for the site-specific pollutants of interest has occurred at PRRI for at least 5 consecutive years; thus, a trends analysis was conducted for the site-specific pollutants of interest. Concentrations of naphthalene have a decreasing trend at PRRI that has leveled out in recent years. Concentrations of fluorene also decreased for several years before increasing in 2016.

- Naphthalene had the highest cancer risk approximations for PRRI. Naphthalene is the only pollutant of interest for PRRI with a noncancer toxicity factor; the noncancer hazard approximations for naphthalene are considerably less than an HQ of 1.0.

- Benzene is the highest emitted pollutant with a cancer toxicity factor in Providence County, while formaldehyde has the highest cancer toxicity-weighted emissions. Toluene is the highest emitted pollutant with a noncancer toxicity factor, while acrolein has the highest noncancer toxicity-weighted emissions for Providence County.

Utah.

- The NATTS site in Utah (BTUT) is located in Bountiful, north of Salt Lake City.

- VOCs, carbonyl compounds, SNMOCs, PAHs, and metals (PM_{10}) were sampled for at BTUT. This site is one of only two NMP sites sampling both VOCs and SNMOCs across both years of sampling.

- Twenty-two pollutants failed screens for BTUT, 11 of which contributed to 95 percent of this site's failed screens. BTUT has the second highest number of individual pollutants failing screens program-wide.

- Of the site-specific pollutants of interest, formaldehyde has the highest annual average concentrations for BTUT, although annual averages could not be calculated for the VOCs for 2015 due to low completeness.

- BTUT has the highest annual average concentrations of hexachloro-1,3-butadiene (2016) and formaldehyde (2015) among NMP sites sampling these pollutants; BTUT also has the second highest annual average of acetaldehyde (2015) among NMP sites.

- Sampling for the site-specific pollutants of interest has occurred at BTUT for at least 5 consecutive years; thus, a trends analysis was conducted for the site-specific pollutants of interest. The most notable trend is for benzene. Concentrations of benzene have a decreasing trend at BTUT. Concentrations of 1,3-butadiene and naphthalene have also decreased in recent years.

- Formaldehyde has the highest cancer risk approximations for BTUT; formaldehyde's cancer risk approximation for 2015 is the highest cancer risk approximation calculated across the program. None of the pollutants of interest have noncancer hazard approximations greater than an HQ of 1.0.

- Benzene is the highest emitted pollutant with a cancer toxicity factor in Davis County, while formaldehyde has the highest cancer toxicity-weighted emissions. Toluene is the highest emitted pollutant with a noncancer toxicity factor, while acrolein has the highest noncancer toxicity-weighted emissions for Davis County.

Vermont.

- The NATTS site in Vermont (UNVT) is located in Underhill, just outside Burlington.

- PAHs were sampled for at UNVT.

- Benzo(a)pyrene and naphthalene were the only pollutants to fail screens for UNVT. One concentration of each failed a screen over the two-year period.

- Both annual average concentrations of naphthalene for UNVT were less than 10 ng/m^3, while both annual average concentrations for benzo(a)pyrene were less than 0.05 ng/m^3.

- UNVT has the lowest annual average concentration of naphthalene and benzo(a)pyrene among NMP sites sampling these pollutants.

- Sampling for the site-specific pollutants of interest has occurred at UNVNT for at least 5 consecutive years; thus, a trends analysis was conducted for the site-specific pollutants of interest. Naphthalene concentrations exhibit a decreasing trend at UNVT.

- UNVT's cancer risk approximations for naphthalene and benzo(a)pyrene are less than 1.0 in-a-million. Naphthalene is the only pollutant of interest for UNVT with a noncancer toxicity factor; the noncancer hazard approximations for naphthalene are significantly less than an HQ of 1.0.

- Benzene is the highest emitted pollutant with a cancer toxicity factor in Chittenden County, while POM, Group 3 has the highest cancer toxicity-weighted emissions. Toluene is the highest emitted pollutant with a noncancer toxicity factor in Chittenden County, while acrolein has the highest noncancer toxicity-weighted emissions.

Virginia.

- The NATTS site in Virginia (RIVA) is located in East Highland Park, near Richmond.

- PAHs and hexavalent chromium were sampled for at RIVA. Hexavalent chromium sampling was discontinued at RIVA at the end of June 2016.

- Naphthalene and hexavalent chromium failed screens for RIVA, with concentrations of naphthalene accounting for 99 percent of failed screens, and thus, is the only pollutant of interest for this site.

- The annual average concentrations for naphthalene were similar to each other in magnitude, both around 70 ng/m^3.

- Sampling for PAHs has occurred at RIVA for at least 5 consecutive years; thus, a trends analysis was conducted for naphthalene. Concentrations of naphthalene exhibit a decreasing trend at RIVA, although those concentrations have leveled off over recent years.

- The cancer risk approximations for naphthalene at RIVA are both less than 3 in-a-million, consistent with previous years. The noncancer hazard approximations are significantly less than an HQ of 1.0.

- Benzene is the highest emitted pollutant with a cancer toxicity factor in Henrico County, while formaldehyde has the highest cancer toxicity-weighted emissions. Ethylene glycol is the highest emitted pollutant with a noncancer toxicity factor in Henrico County, while acrolein has the highest noncancer toxicity-weighted emissions.

Washington.

- The NATTS site in Washington (SEWA) is located in Seattle.

- VOCs, carbonyl compounds, PAHs, and metals (PM_{10}) were sampled for at SEWA.

- Fifteen pollutants failed screens for SEWA, eight of which were identified as pollutants of interest for this site.

- None of the site-specific pollutants of interest for SEWA have annual average concentrations greater than 1 µg/m^3. Acetaldehyde has the highest annual average concentration for 2015 while carbon tetrachloride has the highest annual average for 2016, although the averages for these pollutants are similar to each in magnitude.

- SEWA's annual average concentrations of acetaldehyde and formaldehyde are among the lowest compared to other NMP sites sampling these pollutants.

- Sampling for the site-specific pollutants of interest has occurred at SEWA for at least 5 consecutive years; thus, a trends analysis was conducted for the site-specific pollutants of interest. Concentrations of benzene have an overall decreasing trend at SEWA. Concentrations of naphthalene and 1,3-butadiene exhibit a decreasing trend over recent years.

- Formaldehyde has the highest cancer risk approximations for SEWA, both of which are less than 10 in-a-million. Only one NMP site has a lower cancer risk approximation for formaldehyde among sites for which formaldehyde is a pollutant of interest. All of the noncancer hazard approximations for the pollutants of interest for SEWA are considerably less than an HQ of 1.0.

- Benzene is the highest emitted pollutant with a cancer toxicity factor in King County while formaldehyde has the highest cancer toxicity-weighted emissions. Toluene is the highest emitted pollutant with a noncancer toxicity factor in King County, while acrolein has the highest noncancer toxicity-weighted emissions.

25.1.3 Composite Site-level Results Summary

- Twenty-five pollutants were identified as site-specific pollutants of interest, based on the risk-based screening process. Benzene, acetaldehyde, and formaldehyde were the most common pollutants of interest among the monitoring sites. Benzene was identified as a pollutant of interest for all 34 sites that sampled this pollutant (with Method TO-15 or SNMOC). Acetaldehyde and formaldehyde were identified as pollutants of interest for all 33 sites that sampled carbonyl compounds. Naphthalene was identified as a pollutant of interest for 18 of the 19 sites that sampled PAHs (with GLKY as the exception). Arsenic was identified as a pollutant of interest for all 19 sites that sampled metals.

- Several pollutants were identified as site-specific pollutants of interest for only one or two sites. For instance, dichloromethane is a pollutant of interest for only GPCO; trichloroethylene is a pollutant of interest for only SPIL; and bromomethane is a pollutant of interest for only CSNJ.

- Table 25-1 summarizes which pollutants of interest were identified for each site, how many pollutants of interest were identified for each site, and how many sites for which each pollutant was identified as a pollutant of interest.

- EPA dropped the requirement to sample hexavalent chromium under the NATTS program beginning in July 2013. RIVA is the only NATTS site to continue sampling this pollutant beyond 2014, although sampling was discontinued at the end of June 2016. One concentration of hexavalent chromium measured at RIVA failed a screen (which was measured on July 5, 2015).

- Formaldehyde frequently had the highest site-specific annual average concentration among the site-specific pollutants of interest; formaldehyde had the highest annual average concentration for 28 sites. Naphthalene had the next highest at 10 followed by benzene with five.

- Seven sites have cancer risk approximations greater than 50 in-a-million, eight for formaldehyde (BTUT and ELNJ's annual averages for both years; BROK's annual average for 2015; and AZFL, SKFL, and CSNJ's annual averages for 2016) and two for 1,2-dichloroethane (TVKY's annual averages for both years). Formaldehyde tended to have the highest cancer risk approximation on a site-specific basis. This is true for 31 NMP sites. The highest cancer risk approximation for formaldehyde was calculated for BTUT (109.51 in-a-million, 2015). The second highest annual average-based cancer risk approximation was calculated for 1,2-dichloroethane (97.62 in-a-million), based on TVKY's 2015 annual average concentration. Benzene and 1,3-butadiene are the only other pollutants for which a cancer risk approximation greater than 10 in-a-million was calculated (two and one, respectively).

Table 25-1. Summary of Site-Specific Pollutants of Interest

State	Site	# of Pollutants of Interest	Acenaphthene	Acetaldehyde	Arsenic	Benzene	Benzo(a)pyrene	Bromomethane	1,3-Butadiene	Cadmium	Carbon Tetrachloride	1,2-Dichloroethane	Dichloromethane	Ethylbenzene	Fluoranthene	Fluorene	Formaldehyde	Hexachloro-1,3-butadiene	Lead	Manganese	Naphthalene	Nickel	*p*-Dichlorobenzene	Propionaldehyde	1,1,2-Trichloroethane	Trichloroethylene	Vinyl chloride
AZ	***PXSS***	10		X	X	X			X		X	X		X			X				X		X				
AZ	SPAZ	6				X			X		X	X		X									X				
CA	***CELA***	1																			X						
CA	***RUCA***	1																			X						
CA	***SJJCA***	3			X																X	X					
CO	BMCO	3		X		X											X										
CO	BRCO	3		X		X											X										
CO	***GPCO***	12	X	X	X	X			X		X	X	X	X	X		X				X						
CO	GSCO	4		X		X			X								X										
CO	PACO	4		X		X			X								X										
CO	RFCO	4				X			X		X	X															
CO	RICO	5		X		X			X					X			X										
DC	***WADC***	1																			X						
FL	AZFL	2		X													X										
FL	ORFL	2		X													X										
FL	PAFL	2			X																	X					
FL	***SKFL***	3		X													X				X						
FL	***SYFL***	2		X													X										
IL	***NBIL***	12	X	X	X	X			X		X	X			X	X	X				X		X				
IL	ROIL	6		X		X			X		X	X					X										
IL	SPIL	8		X		X			X		X	X					X						X			X	
IN	INDEM	2		X													X										

BOLD ITALICS = EPA-designated NATTS Sites

Table 25-1. Summary of Site-Specific Pollutants of Interest (Continued)

State	Site	# of Pollutants of Interest	Acenaphthene	Acetaldehyde	Arsenic	Benzene	Benzo(a)pyrene	Bromomethane	1,3-Butadiene	Cadmium	Carbon Tetrachloride	1,2-Dichloroethane	Dichloromethane	Ethylbenzene	Fluoranthene	Fluorene	Formaldehyde	Hexachloro-1,3-butadiene	Lead	Manganese	Naphthalene	Nickel	*p*-Dichlorobenzene	Propionaldehyde	1,1,2-Trichloroethane	Trichloroethylene	Vinyl chloride
IN	WPIN	2		X													X										
KY	ASKY	5				X			X		X	X						X									
KY	ASKY-M	5			X					X									X	X		X					
KY	ATKY	7				X			X		X	X						X							X		X
KY	BAKY	1			X																						
KY	BLKY	7			X	X			X		X	X						X									X
KY	***GLKY***	7		X	X	X			X		X	X					X										
KY	LEKY	6			X	X			X		X	X											X				
KY	TVKY	6				X			X		X	X													X		X
MA	***BOMA***	4			X					X											X	X					
MI	***DEMI***	10	X	X		X			X		X	X		X		X	X				X						
MO	***S4MO***	12	X	X	X	X			X		X	X		X		X	X				X		X				
NJ	CHNJ	6		X		X			X		X	X					X										
NJ	CSNJ	9		X		X		X	X		X	X		X			X						X				
NJ	ELNJ	7		X		X			X		X	X		X			X										
NJ	NBNJ	6		X		X			X		X	X					X										
NJ	NRNJ	7		X		X			X		X	X					X	X									
NY	***BXNY***	4	X				X									X					X						
NY	***ROCH***	4	X												X	X					X						
OK	BROK	7		X		X			X		X	X					X							X			
OK	NROK	8		X		X			X		X	X		X			X						X				
OK	OCOK	8		X	X	X			X		X	X					X	X									

BOLD ITALICS = EPA-designated NATTS Sites

Table 25-1. Summary of Site-Specific Pollutants of Interest (Continued)

State	Site	# of Pollutants of Interest	Acenaphthene	Acetaldehyde	Arsenic	Benzene	Benzo(a)pyrene	Bromomethane	1,3-Butadiene	Cadmium	Carbon Tetrachloride	1,2-Dichloroethane	Dichloromethane	Ethylbenzene	Fluoranthene	Fluorene	Formaldehyde	Hexachloro-1,3-butadiene	Lead	Manganese	Naphthalene	Nickel	*p*-Dichlorobenzene	Propionaldehyde	1,1,2-Trichloroethane	Trichloroethylene	Vinyl chloride
OK	TMOK	10		X	X	X			X		X	X		X			X	X					X				
OK	TOOK	11		X	X	X			X		X	X		X			X			X		X	X				
OK	TROK	10		X	X	X			X		X	X		X			X	X				X					
OK	YUOK	8		X	X	X			X		X	X					X	X									
RI	***PRRI***	2														X					X						
UT	***BTUT***	11		X	X	X			X		X	X					X	X			X	X		X			
VA	***RIVA***	1																			X						
VT	***UNVT***	2					X														X						
WA	***SEWA***	8		X	X	X			X		X	X					X				X						
Total		297	6	33	19	34	2	1	32	2	29	29	1	12	3	6	33	9	1	2	18	7	10	2	2	1	3

BOLD ITALICS = EPA-designated NATTS Sites

- Carbon tetrachloride often had "higher" cancer risk approximations compared to other pollutants of interest among the monitoring sites, ranging between 3 in-a-million and 6 in-a-million, but tended to have relatively low emissions and toxicity-weighted emissions, according to the NEI. This pollutant appears only once in the emissions-based tables for counties with NMP sites (Marshall County, Kentucky, where the two of the three Calvert City sites are located).

- None of the noncancer hazard approximations based on annual average concentrations of the site-specific pollutants of interest were greater than an HQ of 1.0. The noncancer hazard approximation calculated for BTUT's annual average concentration of formaldehyde for 2015 (with an HQ of 0.86) is the highest of all annual average-based noncancer hazard approximations. Formaldehyde tended to have the highest noncancer hazard approximations on a site-specific basis, followed by naphthalene, arsenic, and 1,3-butadiene.

- Of those pollutants with cancer UREs, formaldehyde, benzene, acetaldehyde, and ethylbenzene often had the highest county-level emissions for participating counties. Benzene, formaldehyde, and 1,3-butadiene typically had the highest toxicity-weighted emissions (of those with a cancer URE).

- Of those pollutants with a noncancer RfC, toluene, xylenes, methanol, and benzene were often the highest emitted pollutants, although they rarely had the highest toxicity-weighted emissions. Acrolein tended to have the highest toxicity-weighted emissions of pollutants with noncancer RfCs, although the quantity of acrolein emissions were generally low when compared to other pollutants. Acrolein appears five times among the 10 highest emitted pollutants for counties with NMP sites (Garfield and Mesa Counties in Colorado, Chittenden County, Vermont, and Canadian and Grady Counties in Oklahoma). However, due to the high toxicity of this pollutant, even low emissions translated into high noncancer toxicity-weighted emissions; the toxicity-weighted value was often several orders of magnitude higher than other pollutants. Acrolein is a national noncancer risk driver according to NATA. Besides acrolein, formaldehyde and 1,3-butadiene tended to have the highest toxicity-weighted emissions among the pollutants with noncancer RfCs.

- Although production of carbon tetrachloride has declined sharply over the last 30 years due to its role as an ozone depleting substance, it has a relatively long atmospheric lifetime and thus, is present at similar levels at nearly any given location. NMP sites are located in a variety of locations across the country with different purposes behind the monitoring at each site. In most cases, the concentrations of carbon tetrachloride measured across the program confirm the ubiquitous nature of this pollutant. However, carbon tetrachloride concentrations measured at the Calvert City, Kentucky sites were often higher than levels of this pollutant collected elsewhere. Vinyl chloride is an industrial-marker and is infrequently measured at levels above the MDL (this pollutant has a 31 percent detection rate across the program, though only 10 percent of these measurements were greater than the MDL). The Calvert City, Kentucky sites together account for more than 30 percent of the measured detections of vinyl chloride for 2015 and 2016 (and account for highest 146 concentrations of vinyl chloride measured across the program). Individually, these sites have the highest number of measured detections of vinyl chloride among NMP

sites sampling VOCs. The Calvert City sites also account for the 174 highest concentrations of 1,2-dichloroethane measured across the program. These ambient air measurements agree with corresponding emissions data in the NEI. These three pollutants appear among the highest emitted pollutants in Marshall County, Kentucky (among those with a cancer URE) but are not among the highest emitted pollutants for any other county with an NMP site. From a quantitative standpoint, the emissions of carbon tetrachloride, 1,2-dichloroethane, and vinyl chloride in Marshall County are higher than their emissions in any other county with an NMP site.

- For every NMP site for which 1,2-dichloroethane is a pollutant of interest and where a trends analysis could be conducted for this pollutant (22 sites), a dramatic increase in the number of measured detections is shown over the last five years of sampling, particularly for 2012, which was mostly sustained during the years that follow. This pollutant was detected in less than 10 percent of samples at most sites participating in the NMP prior to 2010 (and still participating now); the rate increased significantly since 2010, slowly at first, then significantly in 2012. The detection rate of this pollutant is between 80 percent and 100 percent for NMP sites sampling this pollutant in 2015 and/or 2016.

25.1.4 Data Quality Results Summary

Completeness, precision, and accuracy were assessed for the 2015 and 2016 monitoring efforts. The quality assessments presented in this report show that the 2015-2016 monitoring data are of a known and high quality, based on the attainment of the established MQOs.

To the largest extent, ambient air concentration datasets met the MQO for completeness; 204 of the 215 site- and method-specific datasets met the 85 percent completeness MQO while 11 datasets (seven from 2015 and four from 2016) did not. Seventy-nine datasets achieved 100 percent completeness.

Method (i.e., sampling and analytical) precision and analytical precision were determined for the 2015-2016 NMP monitoring efforts using CV calculations based on duplicate, collocated, and replicate samples. Method precision for most analytical methods utilized during the 2015-2016 NMP was within the MQO of 15 percent CV (with the exception of Method TO-13A/PAHs). Analytical precision for each method was determined to be less than 15 percent CV. The precision calculations presented in this report are based on analytical results greater than or equal to the sample- and pollutant-specific MDL.

Analytical method accuracy is ensured by using proven methods, as demonstrated by third-party analysis of proficiency test audit samples and following strict quality control and quality assurance guidelines. Most of the pollutants for which audit samples were analyzed met the MQO for accuracy. Of the 143 results analyzed for the 2015 and 2016 audit samples, only

three exceeded the MQO of ± 25 percent recovery (two VOCs and one PAH), and none failed multiple audits.

25.2 Conclusions

Conclusions extrapolated from the data analyses of the data generated from the 2015 and 2016 NMP monitoring efforts are presented below.

- Of the 65 pollutants for which the risk screening process was performed, concentrations of 39 pollutants failed screens. Of these, about one third of concentrations are greater than their respective risk screening values, particularly for many of the NATTS MQO Core Analytes. For several of the pollutants, all or nearly all of the measurements fail screens. Examples of frequently detected pollutants that typically fail all or nearly all of their screens include benzene, carbon tetrachloride, formaldehyde, acetaldehyde, and 1,2-dichloroethane. Some less frequently detected pollutants still fail relatively large numbers of screens. For example, even though hexachloro-1,3-butadiene was detected relatively infrequently (343 measured detections), most (298) of those measured detections failed screens. The MDLs for this pollutant are relatively high (0.34 $\mu g/m^3$ for 2015 and 0.42 $\mu g/m^3$ for 2016) while the toxicity factor is relatively low (0.045 $\mu g/m^3$). Thus, all or nearly all of the measured detections fail screens.

- Although the number of concentrations failing screens varies from year to year, the percentage of failed screens compared to the number of measured detections has been fairly consistent. Between the 2011 and 2014, the percentage has hovered around 36 percent. The percentage for the combined 2015 and 2016 monitoring effort is slightly lower at 32 percent. Risk screening values are often updated from year-to-year, although there were no changes for the 2015-2016 report.

- Among those pollutants for which annual average concentrations could be calculated and that have available cancer UREs, one cancer risk approximation is greater than 100 in-a-million (BTUT, formaldehyde for 2015). In total, 61 cancer risk approximations were greater than 10 in-a-million (52 for formaldehyde, six for 1,2-dichloroethane, two for benzene, and one for 1,3-butadiene); and nearly 83 percent were greater than 1.0 in-a-million.

- Among those pollutants for which annual average concentrations could be calculated and have available noncancer RfCs, none of the noncancer hazard approximations were greater than an HQ of 1.0.

- When comparing the highest emitted pollutants for a specific county to the pollutants with the highest toxicity-weighted emissions, the pollutants tended to be more similar for the pollutants with cancer UREs than for pollutants with noncancer RfCs. This indicates that pollutants with cancer UREs that are emitted in higher quantities are often more toxic than pollutants emitted in lower quantities; conversely, the highest emitted pollutants with noncancer RfCs are not necessarily the most toxic. For example, toluene is the noncancer pollutant that was emitted in the highest quantities for many NMP counties (and did not rank less than third for any county with an NMP site) but was not one of the pollutants with highest toxicity-weighted emissions for

any of these counties. Conversely, while acrolein had the highest noncancer toxicity-weighted emissions for all but one county with an NMP site (where it ranked second rather than first), it was among the highest emitted pollutants for only two counties with NMP sites (and ranked no higher than eighth).

- The number of states and sites participating in the NMP varies from year-to-year. For example, the number of sites included in the 2014 NMP decreased considerably from 2013, from 66 for 2013 to 51 for 2014. This is predominantly due to the removal of hexavalent chromium from the NATTS list of required pollutants for which to sample. Fifty-one NATTS and UATMP sites participated in the NMP for 2015; 51 sites also participated in the NMP for 2016, although the sites participating each year is slightly different.

- Many of the data analyses utilized in this report require data from year-round (or nearly year-round) sampling. Of the 215 site-method-year combinations, 192 combinations covered an entire calendar year. The 23 exceptions include the establishment of two new sites in Oklahoma (BROK and NROK), the discontinuation of sampling at several sites including ROIL, PAFL, and ORFL; the discontinuation of select methods at sites including LEKY, RIVA, and RFCO; and the relocation of instrumentation from NBNJ to NRNJ and from BMCO to GSCO and back again.

- Of the 53 monitoring sites participating in the 2015 and 2016 NMP, none sampled for all six available pollutant groups under the NMP through the national contract laboratory. Two sites (BTUT and NBIL) sampled for five pollutant groups and another seven sites (BROK, GLKY, NROK, PXSS, GPCO, S4MO, and SEWA) sampled four pollutant groups. The wide range of pollutant groups sampled for among the sites, which is often the result of different purposes behind the monitoring at the sites, makes it difficult to draw definitive conclusions regarding air toxics in ambient air in a global manner.

- The data analyses contained in the 2015 and 2016 NMP report reflect the inclusion of data from a number of source-oriented monitoring sites. Source-oriented sites include several of the Kentucky sites and the Camden, New Jersey site. Many of these sites are the drivers for certain pollutant(s) in the report. This can easily be seen in the graphical comparisons of the site-specific averages to the program-level average concentrations contained in Sections 5 through 23. For many of these pollutants, particularly the VOCs, the highest concentrations were considerably greater than the majority of measurements, such that the scale in the figures needed to be greatly reduced.

- This report strives to represent data derived from the best laboratory practices and utilize the best data analysis techniques available. Examples of this include the improvement of MDLs and the incorporation of updated values for various toxicity factors. This can lead to adjusting the focus of the report to concentrate on the air quality issues of highest concern. Thus, the NMP report is dynamic in nature and scope; yet this approach may prevent the direct comparison of the current report to past reports. Relatively few major changes were instituted between the 2014 and 2015-2016 NMP reports. The major difference between the 2015-2016 report and

other reports in recent years is the inclusion of two years of data, and the exclusion of meteorological data.

25.3 Recommendations

Based on the data summaries and conclusions from the 2015-2016 NMP, a number of recommendations for future ambient air monitoring efforts are presented below.

- *Participate in the National Monitoring Programs year-round.* Many of the analyses presented in the 2015-2016 NMP report require a full year of data to be most useful and representative of conditions experienced at each specified location. Therefore, state and local agencies should be encouraged to implement year-long ambient air monitoring programs in addition to participating in future monitoring efforts.

- *Monitor for additional pollutant groups based on the results of data analyses in the annual report.* The risk-based analysis where county-level emissions are weighted based on toxicity identifies those pollutants whose emissions may result in adverse health effects in a specific area. If sampling for a pollutant or pollutant group identified as particularly hazardous for a given area is not being performed, the responsible agency should consider sampling for those compounds.

- *Monitor for additional pollutant groups based on emerging environmental monitoring needs.* With the advent of fracking and the expansion of U.S. oil and gas production, measurements of several groups of oil and gas-related HAPs emissions should be added to the NMP and offered to participants.

- *Continue to identify and implement improvements to the sampling and analytical methods.* Further research is encouraged to identify method improvements that would allow for the characterization of an even wider range of components in air pollution and enhance the ability of the methods to quantify all cancer and noncancer pollutants to at least their levels of concern (risk screening concentrations). An update to the Compendium methods is underway at EPA and is an example of potential method optimization. At the time of publication, a revision to the TO-15 Method was underway at EPA, with a review of Method TO-11A to follow.

- *Perform case studies based on findings from the annual report.* Often, the annual report identifies an interesting tendency or trend, or highlights an event at a particular site(s). For example, dichloromethane concentrations have been highest at BTUT and GPCO for multiple years and trichloroethylene concentrations have been highest at SPIL for multiple years. Further examination of the data in conjunction with meteorological phenomena and potential emissions events or incidents, or further site characterization may help state and local agencies pinpoint issues affecting air quality in their area.

26.0 References

ACE, 2018. U.S. Army Corps of Engineers. Huntington District, Grayson Lake website. http://www.lrh.usace.army.mil/Missions/CivilWorks/Recreation/Kentucky/GraysonLake.aspx Date Last Accessed: 1/24/2018.

ASTM, 2012. ASTM, International. ASTM D7614-12 Standard Test Method for Determination of Total Suspended Particulate (TSP) Hexavalent Chromium in Ambient Air Analyzed by Ion Chromatography (IC) and Spectrophotometric Measurements. http://www.astm.org/Standards/D7614.htm Date Last Accessed: 7/27/2017.

ASTM, 2013. ASTM, International. ASTM D6209-13 Standard Test Method for Determination of Gaseous and Particulate Polycyclic Aromatic Hydrocarbons in Ambient Air (Collection on Sorbent-Backed Filters with Gas Chromatographic/Mass Spectrometric Analysis). http://www.astm.org/Standards/D6209.htm Date Last Accessed: 7/27/2017.

AZ DOT, 2017. Arizona Department of Transportation. Transportation Data Management System website. 2010 and 2015 AADTs. http://adot.ms2soft.com/tcds/tsearch.asp?loc=Adot&mod= Date Last Accessed: 4/20/2017.

CA DOT, 2015. State of California Department of Transportation, Division of Traffic Operations. 2015 Traffic Volumes on the California State Highway System. Sacramento, CA. http://traffic-counts.dot.ca.gov/ Date Last Accessed: 4/20/2017.

Calvert City, 2018. Calvert City - Industry website. http://www.calvertcity.com/ Date Last Accessed: 1/24/2018.

Carbondale, 2017. Carbondale, Colorado. The Town website, History. https://www.carbondale.com/about/history/ Date Last Accessed: 12/12/2017.

Census Bureau, 2015. U.S. Census Bureau. July 2015. List 1. Core Based Statistical Areas (CBSAs), Metropolitan Divisions, and Combined Statistical Areas (CSAs). https://www.census.gov/geographies/reference-files/time-series/demo/metro-micro/delineation-files.html Date Last Accessed: 7/27/2017.

Census Bureau, 2017. U.S. Census Bureau. Metropolitan and Micropolitan Glossary website. https://www.census.gov/programs-surveys/metro-micro/about/glossary.html Date Last Accessed: 7/27/2017.

CO DOT, 2015. Colorado Department of Transportation. Online Transportation Information System (OTIS), Traffic Data Explorer. 2015 data. http://dtdapps.coloradodot.info/otis/ Date Last Accessed: 4/20/2017.

DC DOT, 2015. District Department of Transportation. November 2015. 2014 Traffic Volumes Map. Washington, D.C. http://ddot.dc.gov/page/traffic-volume-maps Date Last Accessed: 4/20/2017.

DC WSA, 2017. District of Columbia Water and Sewer Authority. First Street Tunnel Project website. https://www.dcwater.com/projects/first-street-tunnel-project Date Last Accessed: 12/26/2017.

EPA, 1986. U.S. EPA. 1986. 40 CFR Part 136, Appendix B. Definition and Procedure for the Determination of the Method Detection Limit, Revision 1.11. http://www.ecfr.gov/cgi-bin/text-idx?c=ecfr&tpl=/ecfrbrowse/Title40/40cfr136_main_02.tpl Date Last Accessed: 7/27/2017.

EPA, 1998. U.S. EPA. September 1998. Technical Assistance Document for Sampling and Analysis of Ozone Precursors. EPA/600-R-98/161. Research Triangle Park, NC. http://www.epa.gov/ttnamti1/pamsguidance.html Date Last Accessed: 7/27/2017.

EPA, 1999a. U.S. EPA. January 1999. Compendium Method TO-15: Determination of Volatile Organic Compounds (VOCs) in Air Collected in Specially-Prepared Canisters and Analyzed by Gas Chromatography/Mass Spectrometry (GC/MS). EPA/625/R-96/010b. Cincinnati, OH. http://www.epa.gov/ttn/amtic/airtox.html Date Last Accessed: 7/27/2017.

EPA, 1999b. U.S. EPA. January 1999. Compendium Method TO-11A: Determination of Formaldehyde in Ambient Air Using Adsorbent Cartridge Followed by High Performance Liquid Chromatography (HPLC). EPA/625/R-96/010b. Cincinnati, OH. http://www.epa.gov/ttn/amtic/airtox.html Date Last Accessed: 7/27/2017.

EPA, 1999c. U.S. EPA. January 1999. Compendium Method TO-13A: Determination of Polycyclic Aromatic Hydrocarbons (PAHs) in Ambient Air Using Gas Chromatography/Mass Spectrometry (GC/MS). EPA/625/R-96/010b. Cincinnati, OH. http://www.epa.gov/ttn/amtic/airtox.html Date Last Accessed: 7/27/2017.

EPA, 1999d. U.S. EPA. June 1999. Compendium Method IO-3.5: Determination of Metals in Ambient Particulate Matter Using Inductively Coupled Plasma/Mass Spectrometry (ICP/MS). EPA/625/R-96/010a. Cincinnati, OH. http://www.epa.gov/ttn/amtic/files/ambient/inorganic/mthd-3-5.pdf Date Last Accessed: 7/27/2017.

EPA, 2007. U.S. EPA. May 2007. 1990-2002 NEI HAP Trends: Success of CAA Air Toxic Programs in Reducing HAP Emissions and Risk. Paper presented by Anne Pope at the 16th Annual International Emission Inventory Conference. Raleigh, NC. http://www.epa.gov/ttn/chief/conference/ei16/session6/a.pope.pdf Date Last Accessed: 11/7/2017.

EPA, 2009a. U.S. EPA. April 1, 2009. Technical Assistance Document for the National Air Toxics Trends Stations Program, Revision 2. Research Triangle Park, NC. https://www3.epa.gov/ttnamti1/files/ambient/airtox/nattsTADRevision2_508Compliant.pdf Date Last Accessed: 7/12/2017.

EPA, 2009b. U.S. EPA. September 10, 2009. Schools Air Toxics Monitoring Activity (2009) Uses of Health Effects Information in Evaluating Sample Results. https://www3.epa.gov/air/sat/techinfo.html Date Last Accessed: 11/7/2017.

EPA, 2010a. U.S. EPA. October 2010. A Preliminary Risk-based Screening Approach for Air Toxics Monitoring Data Sets, version 2. EPA-904-B-06-001. Atlanta, GA. nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=P1009A7C.TXT Date Last Accessed: 8/4/2017.

EPA, 2010b. U.S. EPA. December 2010. Data Quality Evaluation Guidelines for Ambient Air Acrolein Measurements. http://www.epa.gov/ttn/amtic/files/ambient/airtox/20101217acroleindataqualityeval.pdf Date Last Accessed: 11/7/2017.

EPA, 2011. U.S. EPA. June 2011. Technical Report for School: Assessing Outdoor Air Near Schools: Riggins School, North Birmingham Elementary School, and Lewis Elementary School (Birmingham, Alabama). http://www3.epa.gov/air/sat/NorthBirmi.html Date Last Accessed: 7/31/2017.

EPA, 2012. U.S. EPA. June 2012. Ambient Air Monitoring Reference and Equivalent Methods: Designation of Three New Equivalent Methods. Federal Register Volume 77, Number 106, page 32632. http://www.gpo.gov/fdsys/pkg/FR-2012-06-01/html/2012-13350.htm Date Last Accessed: 7/27/2017.

EPA, 2014. U.S. EPA. September 2014. UATMP, PAMS, and NMOC Support, Contract No. EP-D-14-030. Date Last Accessed: 7/12/2017.

EPA, 2015a. U.S EPA. December 17, 2015. NATA: Glossary of Terms website. https://www.epa.gov/national-air-toxics-assessment/nata-glossary-terms Date Last Accessed: 8/4/2017.

EPA, 2015b. U.S. EPA. December 2015. Technical Support Document EPA's 2011 National-scale Air Toxics Assessment. Appendix H. https://www.epa.gov/national-air-toxics-assessment/2011-nata-technical-support-document Date Last Accessed: 7/17/2017.

EPA, 2015c. U.S. EPA. December 2015. Technical Support Document EPA's 2011 National-scale Air Toxics Assessment. Pg 20-22. https://www.epa.gov/national-air-toxics-assessment/2011-nata-technical-support-document Date Last Accessed: 7/17/2017.

EPA, 2016. U.S. EPA. September 30, 2016. 2014 National Emissions Inventory, Version 1. https://www.epa.gov/air-emissions-inventories/2014-national-emissions-inventory-nei-data Date Last Accessed: 7/27/2017.

EPA, 2017a. U.S. EPA. Air Toxics - National Air Toxics Trends Stations website. http://www3.epa.gov/ttnamti1/natts.html Date Last Accessed: 7/12/2017.

EPA, 2017b. U.S. EPA. Air Quality System (AQS) website. http://www.epa.gov/aqs Date Last Accessed: 7/12/2017.

EPA, 2017c. U.S. EPA. October 2017. National Air Toxics Trends Stations (NATTS) Network Assessment, 2003-2014. Revised Final. Prepared by Eastern Research Group, Inc.

EPA, 2017d. U.S. EPA. What are Hazardous Air Pollutants? website. https://www.epa.gov/haps/what-are-hazardous-air-pollutants Date Last Accessed: 8/4/2017.

EPA, 2017e. Email from Ted Palma, U.S. EPA, OAQPS. March 30, 2017. Dose Response Library spreadsheet, January 2017 update.

EPA, 2017f. U.S. EPA. Phaseout of Class I Ozone-Depleting Substances website. https://www.epa.gov/ods-phaseout/phaseout-class-i-ozone-depleting-substances Date Last Accessed: 11/14/2017.

EPA, 2017g. EPA Air Toxics - Quality Assurance document listing. https://www3.epa.gov/ttn/amtic/airtoxqa.html Date Last Accessed: 11/1/2017.

ERG, 2015. Eastern Research Group, Inc. 2015. Support for the EPA National Monitoring Programs (UATMP, NATTS, CSATAM, PAMS, and NMOC Support), Quality Assurance Project Plan, Category 1. Contract No. EP-D-14-030. Morrisville, NC. Date Last Accessed: 7/27/2017.

ERG, 2016. Eastern Research Group, Inc. 2016. Support for the EPA National Monitoring Programs (UATMP, NATTS, CSATAM, PAMS, and NMOC Support), Quality Assurance Project Plan, Category 1. Contract No. EP-D-14-030. Morrisville, NC. Date Last Accessed: 7/27/2017.

FAC, 2007. Report of the Federal Advisory Committee on Detection and Quantitation Approaches and Uses In Clean Water Act Programs, Appendix D: DQ FAC Single Laboratory Procedure v2.4. December 2007. Submitted to the U.S. EPA. https://www.epa.gov/cwa-methods/procedures-detection-and-quantitation Date Last Accessed: 7/27/2017.

FL DOT, 2016. Florida Department of Transportation. Florida Traffic Online Mapping Application (2016). http://flto.dot.state.fl.us/website/FloridaTrafficOnline/viewer.html Date Last Accessed: 4/20/2017.

GCA, 2016. Garfield County Administration. Garfield County Profile, 2016. https://garfield-county.com/economic-development/garfield-county-profile.aspx Date Last Accessed: 12/12/2017.

GCPH, 2015. Garfield County Public Health Department. June 2015. Garfield County 2014 Air Quality Monitoring Report. Page 4-4. Rifle, CO. Prepared by Air Resource Specialists, Inc., Ft. Collins, CO. http://www.garfield-county.com/air-quality/ Date Last Accessed: 12/12/2017.

GCPH, 2017. Email from Morgan Hill, Garfield County Public Health. December 19, 2017.

GCRBD, 2014. Garfield County Road and Bridge Department. Garfield County Road Traffic Counts. 2014 Data. http://www.garfield-county.com/road-bridge/county-roads.aspx Date Last Accessed: 4/20/2017.

Girardi, 2015. Girardi, Steven. 2015. Company buys Raytheon property, plans mixed-use development. Tampa Bay Times. July 27, 2015. http://www.tbo.com/pinellas-county/company-buys-raytheon-property-plans-mixed-use-development-20150727/ Date Last Accessed: 12/28/2017.

IL DOT, 2017. Illinois Department of Transportation. Getting Around Illinois website. Average Annual Daily Traffic map viewer. 2013, 2014, and 2015 data. http://www.gettingaroundillinois.com/ Date Last Accessed: 4/20/2017.

IN DOT, 2016. Indiana Department of Transportation. Average Daily Traffic and Commercial Vehicles Interactive map. 2016 Data. http://www.in.gov/indot/2469.htm Date Last Accessed: 4/20/2017.

KY, 2018. Kentucky State Parks. Grayson Lake History website. http://parks.ky.gov/parks/recreationparks/grayson-lake/history.aspx Date Last Accessed: 1/24/2018.

KYTC, 2016. Kentucky Transportation Cabinet. Interactive Statewide Traffic Counts mapping application. 2012-2016 Data. http://transportation.ky.gov/Planning/Pages/count-maps.aspx Date Last Accessed: 5/2/2017.

LADCO, 2003. Lake Michigan Air Directors Consortium. December 2003. Phase II: Air Toxics Monitoring Data: Analyses and Network Design Recommendations. Final technical report prepared by Battelle Memorial Institute and Sonoma Technology, Inc. http://www.ladco.org/reports/toxics/battelle_2/ Date Last Accessed: 7/12/2017.

LBWP, 2013. Lawrence Brook Watershed Partnership. June 2013. Lawrence Brook Fish Ladder Partial Feasibility Assessment. Report prepared by Princeton Hydro, LLC. Ringoes, New Jersey. http://www.harborestuary.org/grants/reports/LawrenceBrookPartialFeasibilityStudyFINALreport.pdf Date Last Accessed: 7/2/2018.

MA DOT, 2010. Massachusetts Department of Transportation, Highway Division. Transportation Data Management System. 2010 Traffic Count. http://www.massdot.state.ma.us/highway/TrafficVolumeCounts.aspx Date Last Accessed: 5/2/2017.

MI DOT, 2015. Michigan Department of Transportation. Annual Average Daily Traffic (AADT) Map. 2015 Data (as confirmed with TMIS report). http://www.michigan.gov/mdot/0,4616,7-151-11151-22141--,00.html Date Last Accessed: 5/2/2017.

MO DOT, 2015. Missouri Department of Transportation, Transportation Planning. 2015 St. Louis District Traffic Volume and Commercial Vehicle Count Map. Jefferson City, MO. http://www.modot.org/safety/trafficvolumemaps.htm Date Last Accessed: 5/2/2017.

NHMU, 2018. Natural History Museum of Utah. Stefan Brems. Salt Lake Valley Weather Patterns. https://nhmu.utah.edu/sites/default/files/attachments/SaltLakeValleyWeatherPatterns.pdf Date Last Accessed: 4/16/2018.

NJ DOT, 2017. New Jersey Department of Transportation. Roadway Information and Traffic Monitoring System Program Interactive Traffic Count Reports. 2010, 2012, and 2014 Data. http://www.state.nj.us/transportation/refdata/roadway/traffic_counts/ Date Last Accessed: 5/2/2017.

NJ DOTr, 2008. New Jersey Department of Treasury. January 2008. New Jersey Traffic and Revenue Study, New Jersey Turnpike & Route 440 Asset Appraisal. Final Report prepared by Steer Davies Gleave in association with CRA International and EDR Group. London, England. http://www.njslom.org/njtrstudypart2.pdf
Date Last Accessed: 5/3/2017.

NOAA, 2017. National Climatic Data Center. Quality Controlled Local Climatological Data (QCLCD). 2015 and 2016 Data. https://www.ncdc.noaa.gov/data-access/land-based-station-data/land-based-datasets/quality-controlled-local-climatological-data-qclcd
Date Last Accessed: 5/11/2018.

NYS DOT, 2015. New York State Department of Transportation. Traffic Data Viewer mapping application. 2015 Data.
https://www.dot.ny.gov/divisions/engineering/applications/traffic-data-viewer
Date Last Accessed: 5/2/2017.

OK DEQ, 2017. Email from Randy Ward, Oklahoma Department of Environmental Quality. July 5, 2017.

OK DOT, 2015. Oklahoma Department of Transportation, Strategic Asset and Performance Management Division, Traffic Analysis Branch. 2015 Annual Average Daily Traffic Oklahoma Highway System maps. Oklahoma City, OK.
http://www.okladot.state.ok.us/maps/aadt/index.htm Date Last Accessed: 5/3/2017.

Peltier, 2016. Peltier Technical Services, Inc. Peltier Tech Charts for Excel 3.0. Downloaded March 8, 2016. http://peltiertech.com/Utility30/ Date Last Accessed: 5/29/2018.

Podmolik, 2015. Podmolik, Mary Ellen. 2015. Canadian Pacific seeks new use for Schiller Park intermodal site. Chicago Tribune. January 20, 2015.
http://www.chicagotribune.com/business/breaking/ct-railway-terminal-development-0121-biz-20150120-story.html Date Last Accessed: 6/4/2018.

RI DOT, 2016. Rhode Island Department of Transportation. State Highway Map of Rhode Island, Traffic Flow Map 2016. 2015 Data.
http://www.dot.ri.gov/about/maproom/index.php Date Last Accessed: 5/2/2017.

SAE, 2011. SAE, International. J1151_201109. Methane Measurement Using Gas Chromatography. September 2011. http://standards.sae.org/j1151_201109/
Date Last Accessed: 7/27/2017.

Seattle, 2018. Seattle Parks and Recreation. Jefferson Park website.
http://www.seattle.gov/parks/find/parks/jefferson-park Date Last Accessed: 5/29/2018.

UT DOT, 2014. Utah Department of Transportation. AADT Traffic Map Updated Using 2014 Data (via Google Earth kmz file).
http://www.udot.utah.gov/main/f?p=100:pg:0::::V,T:,528 Date Last Accessed: 5/3/2017.

UVM, 2015. The University of Vermont. Proctor Maple Research Center Mission website.
http://www.uvm.edu/~pmrc/?Page=mission.htm Date Last Accessed: 3/26/2018.

VA DOT, 2016. Virginia Department of Transportation, Traffic Engineering Division. Average Daily Traffic Volumes with Vehicle Classification Data on Interstate, Arterial, and Primary Routes 2016. http://www.virginiadot.org/info/ct-TrafficCounts.asp Date Last Accessed: 5/3/2017.

Vtrans, 2015. Vermot Agency of Transportation, Highway Division, Traffic Research Unit. June 2015. 2014 (Route Log) AADTs Major Collectors. http://vtrans.vermont.gov/operations/technical-services/traffic Date Last Accessed: 5/3/2017.

WS DOT, 2015. Washington State Department of Transportation. Traffic Data GeoPortal. 2015 Data. http://www.wsdot.wa.gov/mapsdata/tools/trafficplanningtrends.htm Date Last Accessed: 5/3/2017.

WUSTL, 2013. Email from Jay Turner, Washington University in St. Louis. August 29, 2013.

WUSTL, 2016. Washington University in St. Louis, Air Quality Laboratory. Roxana Air Quality Study website. http://raqs.seas.wustl.edu/ Date Last Accessed: 6/4/2018.